# THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 23 MURRAY STREET, NEW YORK.

**M. N. FORNEY, . . . . Editor and Proprietor.**

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**NEW YORK, JANUARY, 1887.**


## PREFACE.

A PUBLIC announcement was made some months ago, that the AMERICAN RAILROAD JOURNAL and *Van Nostrand's Engineering Magazine* had been sold to me, and that the two would be consolidated on January 1st, 1887, under my editorial management. The title for the combined publication instead of being the AMERICAN ENGINEERING MAGAZINE AND RAILROAD JOURNAL, as was first announced, will be THE RAILROAD AND ENGINEERING JOURNAL, which will be devoted to the discussion of engineering and mechanical subjects. Railroad construction and operation being, however, the most important branches of engineering in this country, more space will be devoted to them than to any other one department of engineering. Questions of traffic and finance will not be taken up, excepting so far as they are incidentally concerned with engineering matters.

The JOURNAL, in its new form, will be an illustrated monthly publication, having more the character of a magazine than of a trade journal. The editor will aim to maintain the high character of *Van Nostrand's Engineering Magazine*, but some changes will be made to adapt its successor to a somewhat wider field, which its new proprietor hopes to be able to occupy. An editorial and news department will be added, more engravings will be given, and especial effort will be made to have the typography and printing of both the reading matter and advertisements, and the mechanical work generally, of the best kind. It is intended that, eventually, a larger proportion of original matter will be given in the JOURNAL than has heretofore been published in *Van Nostrand's Engineering Magazine*, but some time will be required to secure contributors and correspondents, so that in the beginning the JOURNAL will contain a considerable proportion of selected articles.

It is impossible, though, to indicate in advance precisely the character which the JOURNAL will assume. Its editor will aim to adapt it to the wants and demands of its readers, and to make it what its title implies—a first-class railroad and engineering journal. Its future numbers will determine its value to its readers, whose verdict, which will be recorded in its subscription list, is awaited with much interest.

Mr. FREDERICK HOBART, who for more than ten years was associated with me in editorial work, will, after January 1st, assist me in conducting this JOURNAL.

M. N. FORNEY.

NEW YORK, January 1st, 1887.

## OUR PROGENITORS.

AS THE RAILROAD AND ENGINEERING JOURNAL is the result of a consolidation of two publications, its advent seems to demand some account of its lineage. Without other prelude then, the history of the oldest of its two ancestors—the AMERICAN RAILROAD JOURNAL—may begin with the announcement of its birth. This was on January 2d, 1832. It is, therefore, the oldest railroad paper in the world. *Herapath's Railway Journal*, in England, which is probably the next oldest, was established in 1835 as the *Railway Magazine*.

It has been announced for years past, on the title page, and elsewhere, in the AMERICAN RAILROAD JOURNAL, that it was established in 1831. This was due to the fact that the first number of the JOURNAL in the office file is dated January 2d, 1831, whereas another copy of this number is dated 1832. As the succeeding numbers in the file are all dated 1832, it shows that the printer fell into the common error of not changing the date with the new year. The mistake was, however, discovered and corrected before the whole of the edition was printed.

The following is the announcement made in the first number:

AMERICAN RAILROAD JOURNAL.

The subscriber proposes to publish a weekly journal, commencing about the first of January, ensuing, to be called the AMERICAN RAILROAD JOURNAL. A principal object in offering the proposed work to the public, is to diffuse a more general knowledge of this important mode of internal communication, which, at this time, appears to engage the attention of almost every section of our country.

The AMERICAN RAILROAD JOURNAL will be printed on a sheet of the largest size (mammoth), and put up in a convenient form for binding, each number to contain sixteen large octavo pages of *three* columns each. The selections, upon the subject of railroads and other works of internal improvement, will be from the best authors, both of Europe and America, and will be occasionally illustrated by engravings. A part of this journal will be devoted to the subject of internal improvement—giving a history of the first introduction of railroads into England, and their improvements to the present day. It will also notice the meetings, in different sections of the country, upon the subject of railroads. The remaining part of the paper will contain the Literary, Miscellaneous and News matter of the NEW YORK AMERICAN, *as prepared for that paper*, omitting *all political* subjects, except such as are of general interest.

The terms of the AMERICAN RAILROAD JOURNAL are THREE dollars per annum, *payable in advance;* and will not be sent without. Any person who will obtain eight subscribers, and remit the amount, shall have a copy gratis; and to companies of *ten* subscribers, who associate and remit twenty-five dollars, it will be sent for $2.50 each per annum. The JOURNAL will be sent for *any* length of time desired, if paid in advance. It will be published on *Saturdays*.

Letters upon the subject of the AMERICAN RAILROAD JOURNAL may be addressed, free of postage, to the publisher and part proprietor,

D. K. MINOR,
No. 35 Wall street, New York.

This was succeeded by the following address:

To The Public.

In offering the American Railroad Journal to the public at this time, when so much and such general interest is felt on the subject of railroads in different sections of the United States, no apology is deemed necessary. The importance of some other mode of internal communication in this country, where the canals and rivers are for about one-third of the year closed by frost, renders it highly desirable that a fair experiment should be made of the utility of railroads. Such experiments are now in progress in several States; and all information, therefore, upon the comparative value of railroads and canals, which may be generally diffused amongst the people, must be valuable, as it may prevent a premature and useless expenditure of capital upon works concerning which sufficient data for a correct judgment are not possessed. Further investigation may lead to the construction of new canals, of the value of which, for a part of the year, we are fully aware; or it may confirm the opinion, fast gaining ground in this country, that railroads will, in a great measure, supersede canals, and, therefore, hasten the construction of a few important lines, through those parts of the country where the amount of business will warrant the undertaking. It is the object of this journal to disseminate as extensively as possible, accurate statements, drawn from European publications, little known, and less read in this country; to record the observations and suggestions of gentlemen of experience in the construction and use of railroads here; and to afford the whole at so cheap a rate, as to be within the reach of every person taking an interest in the subject.

It is intended to give a concise history of the introduction of railroads into England (which appears to have been as early as between the years 1602 and 1649, in the vicinity of Newcastle-upon-Tyne), with the various improvements, down to the present time; and to trace their introduction into, and peculiar adaptation to the business and climate of this country. It will also be the aim of the publisher to show, what *he* thinks may be shown conclusively, that for practical purposes, railroads are far superior to any other mode of internal communication; and that they must, in a few years, entirely take the place of canals, where new works are to be constructed. "The great advantage of railways," says Tredgold, a writer upon the subject, "will consist in their affording the means of transporting *heavy* goods with speed and certainty; and, recollecting that railroads are in an unperfect state, while the united efforts of our civil engineers have been chiefly devoted to canals for about a century, we may confidently hope that there is scope for improvement; and we may fairly infer that for new works railroads will, in nine cases out of ten, be better adapted for public benefit than canals." Entertaining these views, and aware of the general movements making in different sections of the country, for the purpose of adopting measures for the construction of railroads, he is induced to believe that a publication more acceptable, at this time, to a large portion of the intelligent community, could not be offered; and to that class of readers he looks with confidence for a liberal patronage, meaning, as he does, to merit it by untiring zeal to serve them.

After this an article from Wood's "Treatise on Railroads," on the History and Progress of Railroads, is reprinted.

The second page contains a notice of a locomotive built by Bursom & Co., of Philadelphia, which, it is said, "is as simple as a common cart or wheelbarrow," and "works complete, and justifies the belief that it will out-run the far-famed 'Rocket' and 'Novelty.'"

All publishers and most editors will sympathize with a notice on the same page, which is as follows:

"An apology may be due to those gentlemen to whom the first number of the Railroad Journal is sent; if so, the publisher trusts that he will be permitted to apologize, at the *same time*, for respectfully requesting every gentleman who may receive it not only to subscribe *himself*, but to show it to his neighbors, that they may also subscribe, and remit the amount in advance."

This, be it remembered, was written fifty-five years ago. The language, therefore, of this appeal is not that of the present editor of The Railroad and Engineering Journal, but the sentiments which were so felicitously expressed by the founder of the Journal, are in exact accordance with those of its present owner.

The original heading and two others which succeeded it have been reproduced, and are given on the next page. Of the first one it is said, editorially, in the first number that, "it represents the locomotive engine, the 'Novelty,' of Messrs. Braithwait & Ericsson (which competed for the prize of £500, offered by the Directors of the Liverpool & Manchester Railway Company, and which would probably have taken it, but for some trifling difficulty in the machinery), with a carriage for passengers, of sufficient size to accommodate eighteen inside."

Of the second heading, which appeared in the second number, it is said, "the cut at the head of this journal which, although not one of the late improved engines, gives a very correct idea of a locomotive engine with its *train* attached."

The third heading appeared in the first number of the Journal for the year 1833. The editor says of it:

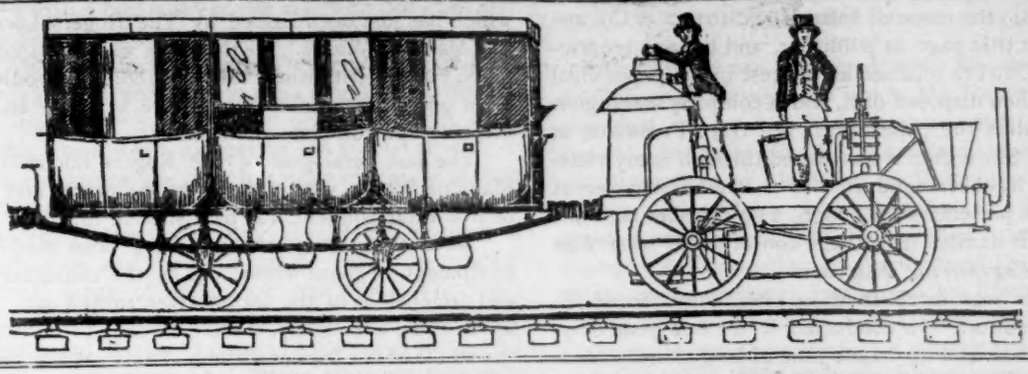
"The cut at the head of the Journal represents the American locomotive engine 'Philadelphia,' built at the West Point Foundry Works, in this city, for the Philadelphia, Norristown & Germantown Railroad, with a freight car, passenger car, passenger coach and private carriage, attached, by way of showing the advantages and facilities which may be enjoyed by the inhabitants living in the vicinity of railroads."

The temptation to linger over these literally musty volumes—because they were in a building during a fire and most of them were soaked with water—is very great. It is proposed to publish in succeeding numbers of the Journal a sort of retrospect of these early volumes, with copious notes and such extracts therefrom as will be interesting at the present day.

The Journal, when first started, and for some years thereafter, was published weekly. Each number had sixteen pages, a little larger than those of the present publication. During its first two years it has a fairly prosperous appearance, but the first number for 1834 contains the announcement that the Journal has not paid its expenses, and that the owner was obliged to advance over a thousand dollars to meet its ordinary expenses. In the first number of 1835, the editor says: "We hope for an increased number of patrons throughout the country. The latter we *must* and *are resolved* to have."

In the beginning of 1837 Mr. Minor associated with himself Mr. George C. Schaeffer. In August the publication of the Journal was suspended, and the September and subsequent numbers for that year did not appear until 1838. On July 1 of that year the *Mechanic's Magazine* was "united" with the Railroad Journal, and the latter was changed to the form and size of an ordinary magazine, with the title of the American Railroad Journal and Mechanics' Magazine. There is perhaps some significance in the fact that no name appears as editor or owner of the publication during the years 1838 and 1839. The June number for 1839 contains the announcement that Mr. Minor had disposed of his interest in the Journal to Mr. Egbert Hedge. He was associated with Mr. Schaeffer until the beginning of 1842, when Mr. Hedge's name disappears from the title page, that of Mr. Schaeffer remaining as editor. In the beginning of 1843 Mr. Minor's name again appears on the title page with that of Mr. Schaeffer as one of the editors and proprietors. In July, 1844, Mr. Schaeffer's name disappears and that of Mr. Minor alone remains as editor. In November of that year he announced that after the 1st of January, 1845, the Journal would be issued weekly in its original quarto form of 16 pages. It was also said in this announcement that when the Journal was originally started "the details of construction occupied the prominent place; whereas now, the *management* of railways, their *cost*, *income* and *dividends*, will especially receive our notice."

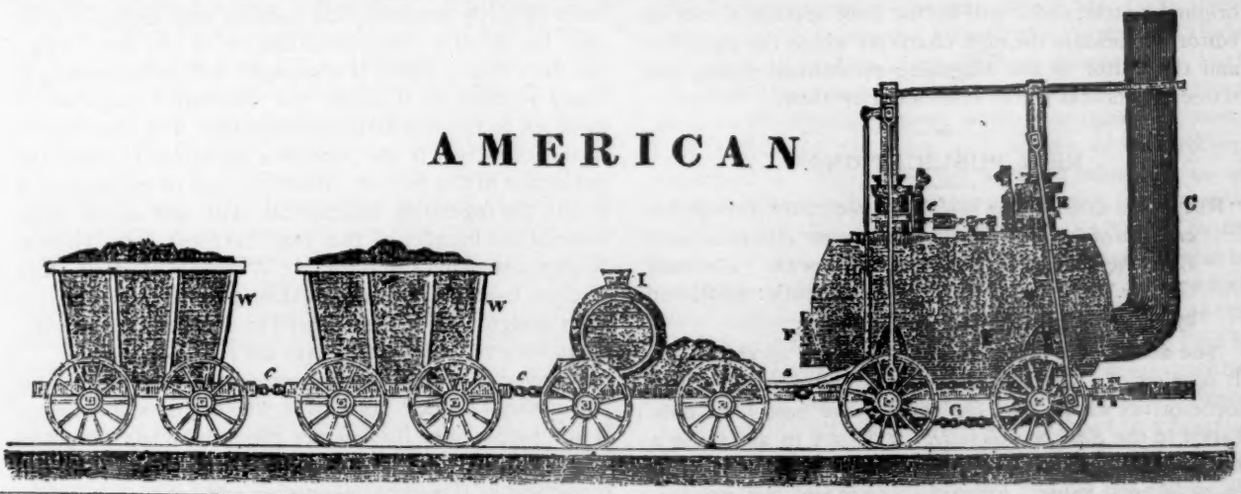
In Nov., 1846, a notice was published that the Journal would thereafter be published in Philadelphia. In January, 1849, the office of publication was removed back to New York, and Mr. Minor then disposed of his interest



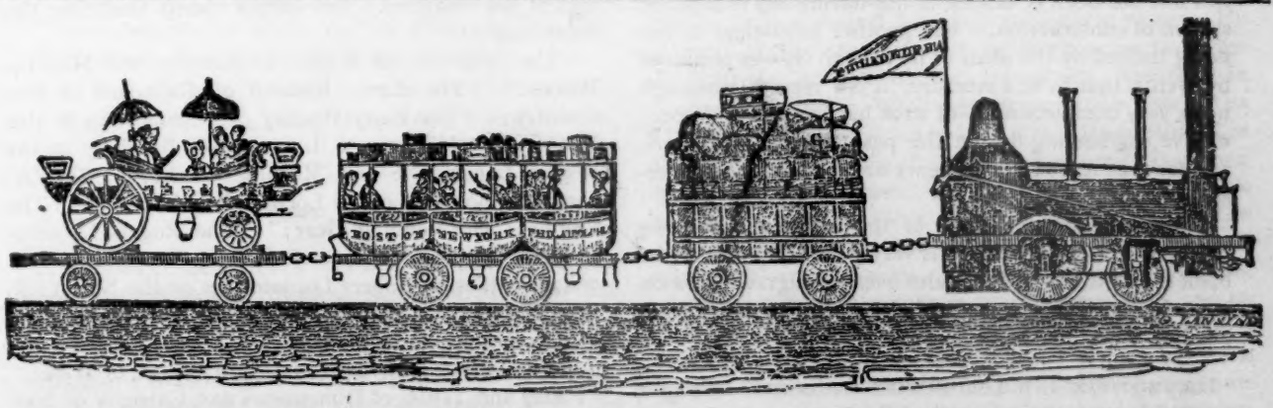
# RAIL-ROAD JOURNAL.

VOL. I. NEW-YORK, JANUARY 2, 1832. NO. 1.

AMERICAN




# RAIL-ROAD JOURNAL.




# AMERICAN RAILROAD JOURNAL,
## AND ADVOCATE OF INTERNAL IMPROVEMENTS.

PUBLISHED WEEKLY, AT No. 35 WALL STREET, NEW-YORK, AT THREE DOLLARS PER ANNUM, PAYABLE IN ADVANCE.

in it to Mr. HENRY V. POOR, who was its editor until 1862. In 1849 the name of JOHN H. SCHULTZ & Co. appears on the title page as publisher, and later as proprietor. Mr. SCHULTZ retained an interest in the paper until 1882. He then disposed of it, and a company was organized to publish the paper, with Mr. GEO. F. SWAIN as President. Since then it has passed through many vicissitudes and has been conducted by a number of different editors. Its present owner bought it on October 1st, 1886, and with this number it has been consolidated with *Van Nostrand's Engineering Magazine.*

The latter was established in 1869, with Mr. H. L. HOLLEY as editor. He conducted it for one year only, and it was then, and up to the time of its discontinuance, edited by Prof. GEO. W. PLYMPTON. The *Magazine* was largely made up from selections from foreign and other engineering literature, but many original articles by able contributors were published in its pages. To some extent THE RAILROAD AND ENGINEERING JOURNAL publication will be like the *Magazine*, but it is intended, with each number, to increase the amount of original matter, and it will be the hope and the aim of its editor to maintain the high character which the publisher and the editor of the Magazine established during the sixteen years that it was conducted by them.

## NEW PUBLICATIONS.

"RECENT LOCOMOTIVES"—*Illustrations, with descriptions and specifications and details of recent American and European Locomotives, reprinted from the "Railroad Gazette."* (Enlarged edition.) New York: published by the *Railroad Gazette.*

The above title indicates the character of this book. It consists of a series of illustrations and descriptions of locomotives which have for some years past been published in the *Railroad Gazette.* It is not in any sense a treatise, and yet as a book of reference it will be found to be of great value. From the way in which it was created it has necessarily a fragmentary character, and as no systematic arrangement was intended, when the illustrations were prepared and published in the *Railroad Gazette*, it has been impossible to systematize them in the book, although the engravings have been arranged in classes for convenience of reference. While a book produced as this one has been is lacking in not having any recognized system of construction, it has another advantage of not being limited by the ideas of its author. It was produced by events, that is, in a measure, it is a record—although not a very complete one—of what has been done in locomotive engineering during the past ten or fifteen years, and for that reason it represents not the ideas of one person but of many.

The printing, paper, most of the engraving, and the mechanical work generally, is very good. The size of the book is 11 x 16 in., and contains over 500 engravings, with a good index. The present edition of the book was compiled by Mr. D. H. Neale.

"LOCOMOTIVES AND LOCOMOTIVE BUILDING"—*Being a brief sketch of the growth of the Railroad System and of the various improvements in Locomotive Building in America, together with a history of the origin and growth of the Rogers Locomotive and Machine Works of Paterson, N. J.* New York: Wm. S. Gottsberger, printer, 1886.

This title is explanatory of the scope of this volume, which has just been issued by The Rogers Locomotive and Machine Works. As this book was prepared by Mr. M. N. Forney, criticism of it in these columns would hardly be in order. The following preface will give an idea of the contents and aims of the book:

"The last catalogue of the Rogers Locomotive and Machine Works, with a sketch of the origin and growth or that establishment, was published in 1876.

"Since then many changes have been made in the equipment of these works, and in the character, design and dimensions of the locomotives turned out. To describe these adequately, it was necessary to rewrite nearly the whole of the former volume. This work was entrusted to my hands by the officers of the Rogers Locomotive and Machine Works. As it was commenced during the fiftieth year that the establishment had been engaged in the manufacture of locomotives, it seemed a suitable time to give a somewhat full account of the origin and history of the works, and of the evolution of the locomotives built in them during that period. Such an account has been carefully prepared, and consists very largely of what may be called a mechanical history of the work which has been done; which, it is thought, will be interesting to many readers, as it shows the successive steps which have led to the wonderful development of the locomotive in this country. It also indicates the extent to which the perfection of the modern American type of locomotive is due to the ingenuity, mechanical skill, and sound judgment of the founder of this establishment—Mr. Thomas Rogers, and to his successor, Mr. William S. Hudson. Both of them have left a record of their genius and ability in their designs, which are imitated to-day, and which promise to survive until locomotives are superseded.

"Very complete data concerning the dimensions and performance of the locomotives, which this establishment is now prepared to furnish, are given by illustrations and tables in the latter part of the book, and as there is still considerable difference of opinion and practice in calculating the capacity of locomotives, an explanatory chapter is given showing just how the calculations were made."

M. N. FORNEY.

The first portion of the historical part is republished in another part of the JOURNAL, and the remainder will appear in future numbers. The following are the headings of the chapters. The author claims credit for the index only:

"The Origin of the Rogers Locomotive and Machine Works;" "The Early History of Railroads in this Country;" "The Early History of Locomotives in this Country;" "History of Locomotive Building at the Rogers Locomotive and Machine Works;" "The Organic Development of the Locomotive: The Boiler: The Engines: The Running Gear;" "The Rogers Locomotive and Machine Works in 1886;" "A Remarkable Run of 426.6 Miles by Rogers Locomotives on the New York, West Shore & Buffalo Railway;" "The Tractive Power of Locomotives;" "Plates and Tables of Dimensions and Capacity of Locomotives of 4 ft. 8½ in. Gauge, or Wider;" "Plates and Tables of Dimensions and Capacity of Narrow Gauge Locomotives;" "Index."

"THE LIFE OF ROBERT FULTON, AND A HISTORY OF STEAM NAVIGATION"—*By Thomas W. Knox.* New York and London: G. P. Putnam's Sons, 1886.

The author of this book says in his preface that he pre-

pared it "in the belief that a history of steam navigation, combined with a biography of the man who designed and built the first successful steamboat, would be of general interest. The use of technical terms, whenever possible, has been avoided, in order that the work might prove acceptable to youthful or non-scientific readers, as well as to those with whom steam navigation is a special study."

As a consequence, the book has more of a popular than a technical character, and is very interesting. The author has apparently investigated very carefully the sources of his information, and the life is largely based on original documents, many of which are reprinted. The book contains many illustrations of Fulton's and other early steamboats, and of later examples of boats and ships. Of the illustrations, he says that, "those referring especially to Robert Fulton are mainly reproduced from Mr. Reigart's biography; they were made originally from drawings by Fulton, and now in the possession of his descendants." To any one who has had experience of the way in which drawings degenerate, the author's easy reliance on the authenticity of those given by another writer is not very assuring of their correctness. It of course takes a great deal of time to investigate and test the accuracy of material of this kind, but a biographer should be willing to do this if he undertakes to write a history of the life and work of a man as distinguished as Fulton was.

The history of steam navigation, which the book contains, while it is interesting, is very fragmentary and superficial, and is evidently not the work of an expert. The material is such as might easily be collected by a not very extended course of reading, and although it is put together in a very readable form, it is not what such a history ought to be, Generally, it may be said of the book that it is good popular reading, but rather indifferent history.

Fulton was buried in Trinity churchyard in New York. The author calls attention to the fact that "the grave of the builder of the first successful passenger steamboat, and of the first steam ship of war that was ever launched, is unmarked by a monument, or even by a stone of any kind bearing his name." Surely this neglect ought to receive the consideration of the engineers of the country.

## BOOKS RECEIVED.

"A PRACTICAL TREATISE ON THE GASES MET WITH IN COAL MINES"—*By the late J. J. Atkinson, Government Inspector of Mines for the County of Durham, England.* Van Nostrand's Science Series.

"THE THEORY AND PRACTICE OF SURVEYING"—*By J. P. Johnson, C. E.* New York: John Wiley & Sons.

## C. Shaler Smith.

The news of the death of this well-known engineer has been received as the JOURNAL is going to press, so that there is time for only a brief mention.

Mr. Smith was born in Maryland, and selected the occupation of a civil engineer when his education was completed. He was for some time associated with the Latrobes—father and son—in Baltimore, and afterward became the engineer of the bridge over the Missouri River at St. Charles, and assisted Captain Eads on the St. Louis bridge. Recently he was engaged in building the bridge over the St. Lawrence, near Montreal. His death occurred in St. Louis on December 19th.

## OBITUARY.

### Leander Garey.

THERE is no one connected with the department of railroad engineering, with which Mr. Garey was so long identified, whose loss would cause such sincere and general sorrow, as did the announcement of his death, which occurred at his home in Hartsdale, Westchester County, New York, on November 24. He died of typhoid fever which probably resulted from fatigue and exposure in conducting an Agricultural Fair, which was held near his residence, just before his illness.

Mr. Garey was born in York County, Maine, Aug. 27, 1827, and he was therefore in his sixtieth year, at the time of his death. His father was a carpenter and joiner by trade, and a farmer as well; part of his time being occupied in working at his trade, and part in farming. When Mr. Garey was about ten years old his father bought a farm in Dover, Maine, and the family then moved to that place. That part of Maine was then a comparatively new country. Only ten acres of the hundred which comprised the farm were cleared. While Mr. Garey lived there with his father, he learned the carpenter's trade, and assisted, as New England boys generally do, in all the work there was to be done. He and his brothers, went to the district school, which was open only about four months in the year, and as one of his brothers expressed it, "we picked up such an education as we could." He remained with his father until he was nineteen years of age and then went back to York County, where he was born, and lived with an uncle so that he could have the advantages of the schools there which were better than those in Dover. Afterward he returned to his home and finished his trade. In 1850 he took a voyage—after the manner of many another adventurous boy—and finally landed at New Orleans, where he fell ill with a fever, and was sent to a hospital. Before his entire recovery he eluded the doctors and left the hospital and returned north. On his way home, and while waiting in the New Haven Depot, he accidentally overheard Mr. French, of Seymour, Conn., say that he needed car-builders in his shop in that place. Mr. Garey volunteered his services, which were accepted, and, although still too weak to work, when he arrived in Seymour, after recruiting his strength, he commenced work for Mr. French. The accidental circumstances in the New Haven Depot, shaped his whole subsequent career. He worked in Seymour for two or three years and then entered the service of the Naugatuck Railroad, in Bridgeport, Conn. While in Seymour he met Miss Hawkins, who became his wife in 1852. He continued in the service of the railroad in Bridgeport until 1855, when he was appointed Master Car Builder of the New York & Harlem Railroad, at a salary of $600 per year. The shops were then in New York City, where the Grand Central Depot now stands. Later the shops at Morrisania, which were burned a year or two ago were built, and he had charge of them until 1873, when he was appointed Superintendent of the Car Department of the New York Central & Hudson River Railroad. The following letter will indicate better than anything else can the opinion which the late Wm. H. Vanderbilt held of Mr. Garey's character and ability.

"The New York Central & Hudson River Railroad Co.,
Office of the President, Grand Central Depot,
New York, Oct. 20, 1873.

"Mr. Leander Garey:

"DEAR SIR:—You are appointed Superintendent of the Car Shops of

LEANDER GAREY.

WILLIAM WOODCOCK.

the New York Central & Hudson River Railroad Co. and its divisions, the appointment to take effect from this date.

"It is not necessary that I should express to you in detail, in this communication, the duties devolving upon you by this appointment; it is sufficient for the purpose, that I state that my confidence in your ability, integrity and efficiency, has induced me to place in your charge the general supervision, control and direction of all new construction, general repairs and expenses, including the estimates and requisitions for purchase of all materials relating to construction and repairs, at the car shops of this company.

"Your designation to this position, is a step long contemplated towards the organization of the car shops into a department, with one person at the head of it, having general powers, and from whose experience and intelligence I can hope to receive all needed information for my consideration and action.

"The immediate result of your appointment, it is expected will be the introduction of order and economy in the shops, and the institution of a system of direct reference to you for authority for any and every expense to be incurred.

"For the accomplishment of the beneficial results anticipated by me, ample power is given to you.

"The position is one of trial and trust, requiring experience, fidelity, discretion and energy to insure success. In the discharge of its duties you will always have my official and personal encouragement. Your relation to the heads of other departments will be advisory, and it will be your duty, as I believe it will be your pleasure, to co-operate with them as far as possible, in protecting and promoting the interests of the company.

"I remain, dear sir, very truly yours,

"W. H. VANDERBILT. Vice-President."

His relations with Mr. Wm. H. Vanderbilt, and his father before him, were of the most confidential and friendly character, and there can be little doubt that they were both very much influenced by Mr. Garey's advice and opinions in those matters which he understood best. He occupied the position on the New York Central road until January 1st, 1885, when he resigned, and soon after he took a pleasure journey to California, which seemed, on his return, to have rejuvenated him, and to have given him a fresh lease of life.

His illness was without premonitions, and from the beginning the fatal disease assumed a very maligant type.

Mr. Garey was, however, more widely known through his connection with the Master Car Builders' Association, of which he was one of the organizers, and in its work and meetings he took an active part. In 1870 he was elected Secretary, and in 1874 he was made President, and was re-elected to that office for ten consecutive years. The writer of this account of his life, has had exceptional opportunities of knowing the deep interest, the zeal and the great amount of work which he devoted to the interests of that Association, and he can say, that to Mr. Garey, more than to any other person, the success of that Association is due. In its critical periods, he was ready with his advice and tact, to steer it clear of the rocks in its way. He was always on the side of progress, and hardly a step in advance was taken in which he was not a leader. In 1872 a resolution was adopted, "that a committee be appointed with power to publish an illustrated book, defining the proper terms or names of each and every part used in the construction of railway cars and a description of the use of the same." Mr. Garey was one of the Committee, but probably neither he nor any other member of it realized the work which they had undertaken. The Committee at first consisted of ten members, who held several meetings. The meetings were very amusing, as agreement among the members was impossible, and it soon became obvious that a committee of ten was too unwieldy to construct a dictionary. The Committee was finally reduced to three, of which Mr. Garey and the writer were members. The work to be done was rather remarkable. The art of car building had grown and been differentiated—as Herbert Spencer would say—more rapidly than the language relating to it. The need of the car-builders, which led to the appointment of the committee, was, that there were no common names for the different parts of cars, so that if a car-builder in Chicago wanted to order castings from another in Boston, it was not at all certain that the Boston man would know what his Chicago friend meant by his terms. In other words, there were no common words to designate the different parts of cars, and in some instances, a term was applied to one thing in one place, and to quite a different one in another. The task of the committee was to establish, and often create, terms to designate all the parts of cars. This, as has already been stated, was a task very much greater than any of the Committee ever imagined when they were appointed. Mr. Garey took up the work with enthusiasm. The plan which was finally adopted after a good many ineffectual efforts were made, was to assign the work to be done to one person, the other two members acting as advisers. No record was kept of the meetings, but probably as many as fifty were held before the book was completed. These meetings were generally of several hours' duration, and Mr. Garey was seldom absent from any of them, and he always took a deep interest in what was done. Whatever value the Car Builders' Dictionary may have, is largely due to the knowledge and assistance which he contributed to the work, and to his indefatigable efforts in completing it.

He has left a wife, three daughters and one son, who, with his many friends, will mourn his death. He was always honored by the affection and esteem of his employés. By all of them, by the members of the Association of which he was President, and all who were ever brought into near relations with him, his death has been the cause of profound sorrow.

## William Woodcock.

IT is a singular coincidence that the notice of the death of Mr. Garey, who, for so many years, was the President of the Master Car Builders' Association, and that of William Woodcock, the President of the Master Mechanics' Association, should appear simultaneously in so many papers. William Woodcock died at his home in Elizabeth, N. J., at noon on Nov. 27. He had been ill about three weeks.

He was a native of England, and came to this country when a child. He learned the machinists' trade in a railroad shop at Parksburg, Chester County, Pa., and soon after became foreman of a shop in Harrisburgh. Afterwards he was made foreman of the repair shops of the Delaware, Lackawanna & Western Railroad in Scranton. From there he went to Philadelphia, as Superintendent of the Philadelphia & Reading Railroad shops, at Ninth and Green streets. In 1870 he was offered the position of Master Mechanic of the Central Railroad of New Jersey, which position he held under Mr. Peeples, who was Superintendent of Machinery. On the resignation of the latter gentleman his duties were delegated to Mr. Woodcock, and he occupied this position until his death. He had charge of the machinery of the Central Railroad of New Jersey, the Long Branch and New Jersey Southern Branches.

Mr. Woodcock was one of the class of mechanics, which is so large in this country, who have come up from the ranks and been promoted to more responsible positions. He took a very great interest in everything relating to his

occupation, and especially in the affairs of the association of which he was President. Although not a highly educated man he was a diligent student of all that related to his calling, and took a keen interest in all improvements in the machinery of railroads. He was chosen Second Vice-President of the Master Mechanics' Association in 1884, First Vice-President in 1885, and last June was elected President. In one of the local papers of Elizabeth it was said that:

"Mr. Woodcock was a man of quiet, unassuming manners, and yet public spirited, taking an active interest in the welfare of the city. He was a man of great benevolence, doing much for charity that escaped publicity, and was never heard of except through the beneficiaries. He was also connected with benevolent institutions. He was one of the Board of Directors of the Elizabeth General Hospital and Dispensary; and a Trustee of Evergreen Cemetery.

"In politics he was a Democrat, and as the candidate of that party was elected a member of the Board of Education from the First ward, when that ward had a pronounced Republican majority. Mr. Woodcock served well his constituency, and brought an experience in educational and mechanical affairs into the management of the schools that will be of a permanent benefit. He was, at the time of his death, and had been for several years, a member of the Board of Health, where, too, his mechanical skill was of great practical use in matters of this department.

"Mr. Woodcock was an active church worker, and in none of his public relations will his loss be more severely felt than in the Marshall street Presbyterian Church, of which he was one of the elders.

"He was a member of the Knights Templar Commandery in Lancaster, Pa.

"Mr. Woodcock leaves no immediate family. His wife died a few years ago. A sister and brother survive him. His death falls with much severity upon a niece, who had a home at Mr. Woodcock's since a child, and was as a daughter to him.

"The railroad company recognize the loss of a valuable and faithful employé, whose place cannot be easily filled. The hundreds of men who for years have been under his direction will regard his death with feelings of great sorrow. He was a kind and helpful master, and esteemed by all who had dealings with him. Mr. Woodcock was 52 years of age."

## Walton W. Evans.

THE death of this distinguished engineer occurred in his seventieth year, in New York, on Nov. 28th. The following account of his life is from the *New York Herald*:

"At the time of his death Mr. Evans was, with a single exception, the oldest living graduate of the celebrated Polytechnic Institute at Troy, in this State. One of his first connections with that series of railroad works of magnitude which have made his name famous, not only on the American continent, but in Australia and New Zealand, was his association with the engineers who built the Harlem Railroad.

"He continued in the practical exercise of his profession for several years in different sections of the country wherever engineering skill was required to push the lines of communication from city to city and State to State, in defiance of every obstacle in the way. He was then invited by the Chilean government to visit that country, where he at once commenced building railroads, being, soon after his arrival there, appointed Chief Engineer under the Republic. In this capacity he built nearly all the important railroads which traverse that country. He visited several of the other South American republics, projecting and building railroads, and adding to the prosperity of the government and the happiness of the people by his works.

"Besides his railway enterprises, one of which was the building of the first steam railroad south of the Equator —an enterprise of which he was especially proud—Mr. Evans designed and superintended the erection of many of the public edifices and private mansions which adorn the capitals of the South American republics. Central America and Mexico are also indebted to the deceased engineer for the blessings of that higher civilization which follows on the opening of railways through rich and fertile countries previously undeveloped.

"He also devoted his time to the consideration of canal construction, and has written a series of articles on inter-ocean canal communication which have attracted great attention on this continent and in Europe. He was an indefatigable student, never wearying in the study of the problems which presented themselves in the carrying out of novel and previously untried enterprises, and elucidating, with the accuracy of the draftsman and the clearness of an apt writer, the difficulties presented and overcome in his experiments. Many of his writings in this direction are valuable additions to the engineer's library.

"Mr. Evans was a member of the Institution of Civil Engineers, the American Society of Civil Engineers, and of the Council of the American Geographical Society. He has also filled many positions of trust and responsibility on special occasions in connection with his profession, bringing his close study and critical test of every new invention and design into practical operation. Whenever in the employment of foreign governments or corporations, he contended for and always secured the introduction of American mechanical products in the prosecution of his undertaking. His loss will be deeply felt by his professional brethren, not only in his own country, but in those lands where, through his works or writings, his name is known.

"Mr. Evans was the grandson, on the maternal side, of General Anthony White of revolutionary fame, and was a member of the Society of the Cincinnati."

Mr. Evans was an enthusiastic advocate of American ideas and methods in engineering matters, and to him the introduction and use of American rolling-stock and machinery in South America, Australia and other foreign countries was largely due. He was one of the few engineers who discovered the fallacies of the narrow gauge illusions, which, about fifteen years ago, were disseminated in this and other countries. He was a frequent writer on engineering subjects, and when he did write, it was always to express some very pronounced and decided views on the subjects he discussed.

He was appointed the agent of a number of South American and other foreign enterprises, in this city, some years ago. He was entrusted with the responsibility of purchasing the rolling-stock and supplies, engaging the engineering staff and transacting the business generally of these enterprises—all of which was left largely to his discretion. Owing to the infirmity of defective hearing, he went little into society, and his diversion consisted

largely in the study of engineering matters, for the discussion of which he was always ready, and which he would take up with all the enthusiasm of youth.

His death has removed one of the type of engineers--who are now disappearing so rapidly—who were trained during the period of the growth, or rather the creation of engineering in this country. Besides the knowledge and ability as engineers which distinguished these men, many of them have been noted for their kindly human sympathy, benevolence and magnanimity, which are sadly missed as they one by one pass away.

### Martin Coryell.

OUR personal record this month mentions the deaths of an unusual number of prominent engineers. One of the latest on the list is Mr. Martin Coryell, the well-known mining engineer, who died at his home in Lambertville, N. J., Nov. 29th, aged 71 years. He was born in New Hope, Pa., in 1815, and received his education in the schools of that place and in the academy at Lambertville, then a school of some local reputation. Mr. Coryell early began his training as an engineer, and continued work in that profession until his death, with the exception of two short intervals in his youth, one when he read law for a short time in Philadelphia, in the office of Mr. Benjamin H. Brewster (afterward Attorney General of the United States), and one when, after a severe illness, he worked at the carpenter's bench to restore his health. His first work as assistant engineer was on the Delaware Division Canal in Pennsylvania, and he subsequently served on the Delaware & Raritan Canal in New Jersey. Here he was associated with the late Ashbel Welch, who was, years afterward, his friend and neighbor; and he subsequently assisted Mr. Welch in the location and construction of the Belvidere Delaware Railroad. This was his last railroad work, for he then turned his attention to mining engineering. He was one of the pioneers in mining in the Lake Superior copper region, and, on his return from the West, was connected with the development of the Hazleton anthracite field, and of the other coal fields opened by the building of the Lehigh Valley Railroad. In 1862, his coal mining work led him to settle at Wilkesbarre, Pa., which was his home for several years. In 1864, he was appointed manager of the Warrior Run Coal Co., and directed the operations of that company for several years. About 1875, he left Wilkesbarre and settled in Lambertville, N. J., his time being fully occupied by his coal interests and an extensive practice as consulting engineer, his advice being sought as that of a leading expert in his profession.

Mr. Coryell was one of the founders of the American Institute of Mining Engineers, and was always an active member, taking part in the meetings and contributing valuable papers to the proceedings. His death is regretted by a wide circle of friends.

### Submarine Warfare.

(From the *London Times*.)

THE question of submarine warfare would appear to be advanced an important stage by a new submarine torpedo boat, which was tried on Saturday, November 27th, in the West India Docks. The great problem for solution in this class of boat is a simple and ready means of effecting submersion quickly, and of again rising to the surface as frequently as may be desired. Many attempts have been made to compass this object by means of screws, inclined planes, water compartments alternately filled and emptied, and other contrivances. The present invention, however, involves none of these principles. The principle upon which the immersion and emersion of the new boat depends is simply that of displacement. While lying on the surface, the boat has a given amount of displacement. To effect immersion, this displacement is reduced, and when it is desired to raise her to the surface again the displacement is increased. A fair analogy is that of a telescope dropped into the water when extended for use, in which condition it will float for a given time. If dropped into the water closed up it will straightway sink to the bottom. The idea of utilizing this principle originated with Mr. Andrew Campbell, and was worked out in practice by him in conjunction with Mr. Edward Wolesley and Mr. C. E. Lyon, and the vessel in which the joint ideas of these gentlemen have been embodied has been built by Messrs. Fletcher, Son & Fearnall, of Limehouse. This boat is cigar-shaped, and pointed at both ends, being 60 feet long and 8 feet in diameter amidships, exclusive of a slightly raised central deck. Her displacement, when fully immersed, is about 50 tons. She is built of ⅜-inch Siemens-Martin steel, and is driven by twin screws, the motive-power being electricity, which is supplied from a storage battery to motors of 45-horse power. Electricity also supplies light, when submerged, by means of glow lamps. Air under pressure is stored on board, and there is accommodation for a three days' supply; the electric batteries also have a similar storage capacity. The electrical machinery has been designed by Mr. Graydon Poore, and supplied by Messrs. Lewis Olrick & Co.

When lying on the surface of the water, a depth of only about ten inches of the central upper portion of the boat is visible above water-line, and this is surmounted by a steel conning tower about 12 inches high and 15 inches diameter, and pierced with four sight holes. Entrance and exit are obtained by means of a manhole on the deck which is secured with a watertight joint, and there is room for six persons in the central portion of the boat. Displacement is increased or reduced by means of cylindrical chambers, which are projected or withdrawn telescopically from the sides of the vessel, and by this simple means she can be made to rise or fall in the water, slowly or quickly, at the will of those in command. This was amply demonstrated on Saturday, when Lord Charles Beresford, with others, went down in her, Lord Charles expressing himself very strongly as to the value of this new vertical manœuvring power. The boat was many times submerged to the bottom of the dock, about 17 feet, and brought to the surface again on a perfectly even keel. She was also propelled a short distance, connection being made with the batteries by hand, but as the motors were not coupled up with the current nothing further was attempted. The area for a run, moreover, was too circumscribed, there being a number of vessels lying in the docks, which would have impeded progress. The main application of the system would appear to lie in the direction of submarine warfare, although it is not intended that it shall subserve this purpose exclusively, as the inventors have designed arrangements for applying it to all classes of submarine operations in lieu of the diving bell. It is also to be observed that, although only applied to a 60 feet boat, this size in no way indicates a limitation of the principle, which can be applied to any sized vessel.

# Contributions.

## NATURAL GAS.

### A MONOGRAPH.

BY CHARLES PAINE.

NATURAL gas, or Rock gas, as it it often called, is a fluid of vapor of about one-half the specific gravity of atmospheric air, varying, according to the place of its origin, from .45 to .55, and of course, according to its composition, which is found to differ considerably in adjacent wells, and even at different times in the same well. There have been many determinations of the composition of Pittsburgh Natural gas, the average of which, adopted by Mr. S. A. Ford, the chemist of the Edgar Thompson Steel Works, is as follows:

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|---|---|---|
| Carbonic acid | .6 | per cent. |
| Carbonic oxide | .6 | " |
| Oxygen | .8 | " |
| Olefiant gas | 1. | " |
| Ethylic hydride | 5. | " |
| Marsh gas | 67. | " |
| Hydrogen | 22. | " |
| Nitrogen | 3. | " |
| | 100. | |

The Findlay, Ohio, gas, as determined by Prof. C. C. Howard, yields:

| | | |
|---|---|---|
| Marsh gas | 92.61 | per cent. |
| Olefiant gas | .30 | " |
| Hydrogen | 2.18 | " |
| Nitrogen | 3.61 | " |
| Oxygen | .34 | " |
| Carbonic acid | .50 | " |
| Carbonic oxide | .26 | " |
| Sulphuretted hydrogen | .20 | " |
| | 100.00 | |

The heat units in 100 litres of Pittsburgh gas are calculated at 789,694; in Findlay gas at 878,082; and (for the sake of comparison) in the same quantity of Siemen's producer gas at 113,000; these results being the average of several determinations. Experiments under various boilers have shown 1,000 feet of gas to be equal in heating power to from 80 to 133 pounds of coal. The committee of engineers of the Society of Western Pennsylvania, appointed to investigate the question, concluded that one pound of coal was equal in value to seven and a half feet of average Natural gas. It explodes violently when mixed with from nine to fourteen parts of air. The flame temperature of Natural gas, when burned with pure oxygen, is estimated by Mr. F. W. Taylor at 7,100 degrees C., and of the Siemen's producer gas at 2,850 degrees centigrade; when burned with just enough air to insure perfect combination, the temperatures are estimated at 2,333 degrees C. for Natural gas, and 1,700 degrees C. for Siemen's.

The Natural gas has generally but little odor; yet is often found strongly scented with the fumes of petroleum or of sulphuretted hydrogen. The absence of odor has usually been considered a defect, as lessening the chances of discovering leaks from the pipes in which it is carried; but the sense of suffocation produced by inhaling air which has been charged with only a very small portion of the gas, would seem to be a warning of its presence quite as palpable as its odor. The gas is described as colorless, yet it may be seen to have a pale blue tint when blown into the air from a well under high pressure, quite like the column of high-pressure dry steam from a boiler. This color may be due to the presence of minute quantities of water, or of oil, in suspension; for, as discharged from the wells, there is always some moisture and some oil, which may be separated from the gas by discharging it into a tank on its way to the conducting mains, the precipitated water and oil being drawn off at proper intervals.

The theories of the origin of gas are several; and it is not worth while to discuss them here at much length, because none of them accounts for all the facts; and, at present, the theories have not much practical bearing. The probabilities are that petroleum and gas are derived from the same sources; they are always found in conjunction. They appear to have been produced from organic matter, to have escaped from the region in which they were produced, and to have been entrapped in certain open or porous rocks, where they have remained imprisoned until discovered by the drill, or by their issuing through crevices in the rocks, leading to the surface.

It is probable that gas may be found in any of the strata which have been deposited since the Archæan rocks. In Northwestern Ohio the gas is found in the Trenton limestone, which is in the second series of strata above the Archæan rocks; and more or less gas has been found in each of the subsequent strata up to the coal measures; indeed, it exists even in the glacial drift.

Starting at the oil region in Upper Canada, passing through Black Rock to the southwest corner of Pennsylvania, the sedimentary rocks dip gently and somewhat uniformly to the southwest, the lower rocks outcropping at the northeastern end of the section, while the full series, extending to the upper barren coal measures, are found at the sonthwestern end. It is remarkable that upon this line, the oil or gas, in profitable quantity, is found only in those strata of sandstone which happen to be at a depth of from 500 to 2,000 feet below the surface; and that deeper drilling in any place along this line has not succeeded in finding a stratum which was, at that place, productive of either oil or gas in valuable quantity, although yielding both in abundance at some other locality, where it is nearer the surface.

In Canada, the oil is found in the Carboniferous limestone. As we go southwestward, the Bradford sand, the next group above, is the productive stratum; still further south, the Warren oil group, which lies above the Bradford; further southward, and above the Warren, the Venango group of sands, and still further to the southwest, the Conglomerate measures yield the gas and oil. In Northeastern Ohio, in the vicinity of Mecca, the oil is found at small depths, less than one hundred feet, in the Berea grit, immediately under the bowlder clay; but its gas, and almost all the volatile products usually contained in the petroleum, have been evaporated; in consequence of which the oil attains the gravity of from 26 to 28 degrees "B," which made it the valuable lubricating substance for which there was a wide demand, so long as its production continued. The gas and oil in Northwestern Ohio, found in the Trenton, lie about 1,100 feet below the surface.

The reservoirs of gas and of oil seem to vary in dimensions from the smallest pocket up to thirty or forty square miles in extent, and one hundred feet or more in thickness. It is important to the finding of the gas that the rocks shall not have been violently disturbed and broken, because the gas certainly would have escaped through the openings produced by the fracture of the rocks; so that it would appear idle to search for it in the immediate

proximity of mountain chains; but it may be looked for in almost any quarter, wherever the strata have not been violently disturbed, between the Upper Carboniferous and the Archæan. In Southwestern Pennsylvania these strata are very closely conformable and of remarkable uniformity in thickness; but in no other part of this country is it possible, without very careful investigation to determine at what depth a specified stratum will be found. The several contiguous strata may contain water, oil and gas in intimate mixture, or they may be separated by short intervals one from the other. The natural expectation that the gas would be found at the top, then the oil, then the water, is frequently reversed; and in some places we first pass through a stratum of salt-water, then a stratum yielding oil, and finally reach the gas in a lower stratum. It is manifest that there is no communication between the strata, where this condition of things exists. When first reached, the tension of the gas is commonly very high. The highest measured pressure of which we have knowledge is 750 pounds to the square inch; but, from various phenomena exhibited, and the judgment of well-diggers, familiar with these astonishing pressures, we may conclude that a thousand pounds per square inch is not very unusual at the first penetration of the drill into the reservoir. It is not at all uncommon for the drill, and the rope, and even the casing, to be blown out of the hole, from a depth of 1,500 feet, over the top of the derrick, like an arrow from a bow-gun. In any given pool, as it is called in the oil country, there seems to be a sufficient porosity of the rock, in which the deposit is contained, to admit of an approximate equalization of pressures among the several wells, so that throughout an area of one or two miles square, the wells, if shut in, will have substantially the same pressure, not varying among themselves more than thirty or forty pounds per square inch.

For the last few years, much credit has been attached to the anticlinal theory, in the searches for oil and gas. The drillers, in Western Pennsylvania, have faith in an angle of 45 degrees from the meridian, northeast and southwest; so that a successful well having been obtained, they immediately start the drills upon a line protracted upon the northeastern and southwestern courses from it. It happens that in Western Pennsylvania the folds in the strata, which form the anticlinals and synclinals, are approximately parallel with the crest of the Allegheny Mountains, which run rudely to the southwest from the northern boundary of the State, although with a very decided bend, which is followed by the foldings, and also by the remarkable parallelism of the oil territory, so far as it has been exploited. Of course, the real position of the anticlinal fold can only be determined by careful geological explorations on the spot. Prof. I. C. White, the champion of the anticlinal theory, has had remarkable success in the location of the wells which have been sunk under his direction; nevertheless, there are excellent gas and oil producers, which lie exactly in a synclinal trough. It, therefore, appears of more consequence to find a reservoir which has received and retained the gas, than that it should be situated either at the top or bottom of a fold in the strata. Of course, upon the exhaustion of the reservoir, the last few pounds or ounces of pressure would be obtained from the summit of the reservoir; but only the drill can tell whether the reservoir extends to the top of the fold, or lies entirely in the bottom of the synclinal. The reservoirs in the sandstones were formed before the folding of the strata. The denser strata of sandstones or shales surrounding the porous masses, containing the gas, do not seem to be permeated by it in any sensible degree. Those who wish for more particulars on this point, are referred to the interesting discussions by Professors Leslie, Ashburner, Carll and White. At the last meeting of Mining Engineers at St. Louis, Mr. Ashburner read an especially instructive paper upon the geologic distribution of Natural gas in the United States; which will be found among the proceedings of that Society. In it, he thoroughly explains how mystified and misled any but an expert geologist must be, in an endeavor to calculate the depth at which certain strata will, at any point not contiguous to previous drillings, be reached; yet such an expert geologist can advise, after sufficient examination, with reasonable certainty as to the depth at which strata, capable of bearing oil or gas, may be found. Of course, only the drill can tell whether either is there in abundant quantities, or not; even a distance of a few rods or a few feet, may separate a very productive well from a non-productive.

The method of drilling for gas is precisely similar to that employed in drilling for oil, which has been redueed to such a trade and organized business, that one may order from one establishment every article necessary for an outfit. Ordering a "carpenter's rig" from the men who make a business of furnishing such, they will ship to the point desired, for the sum of about two hundred dollars, every piece of timber or lumber which is required for the erection of a standard derrick, with all its attachments; another firm supplies the rig irons for about sixty dollars. The rig-builder, for the sum of about one hundred dollars, will put these parts together; set up in complete readiness for the operations of the driller. The driller furnishes the engine, rope, tools; and drills the hole required (if inside of 2,000 feet deep) at a price varying, with the territory, the hardness of the rock, and the distance from the base of supplies, from $1.00 to $2.00 per foot in depth. If water is encountered, it must be cased off by inserting a tube called the *casing*. The standard well-casing is 5⅝ inches interior diameter, which will go easily into the standard eight-inch hole; the hole below this casing is 5½ inches in diameter. A complete description of the processes of well-sinking, showing the tools used, etc., will be found in Prof. Carll's "Report on the Oil Wells of Pennsylvania," Vol. III, of the Pennsylvania Geological Survey.

One of the most remarkable features of well-sinking is the indifference of the drillers to the loss of their tools. It would seem as if they regard it as a pleasant feature of the business to have a "fishing-job" on hand, as they term it; when they have, by their carelessness, allowed their tools to fall in a hole something over one thousand feet deep, because of the rope or the derrick-head, or something else wearing out and breaking. The next most surprising thing is the ingenuity of the contrivances which have been devised to recover from this seemingly hopeless calamity. In the majority of instances they do manage to pick up the tools and to continue the well. The whole apparatus for well-sinking is of the most rude and simple description of anything known to mechanics; yet so admirably adapted to its work that it would be difficult to improve upon it in any respect, except as to its appearance.

It seems to be well determined that the gas in any reservoir is a limited quantity and not an infinite one, as has been supposed. No doubt the laboratory of Nature

is at work producing the gas, perhaps in very large quantities at the present time, as heretofore; but we do not know certainly that the process of gas production is taking place in the vicinity of the reservoirs which we have discovered. A great many of the small reservoirs have been nearly or quite exhausted, although many of them continued to supply the limited demand which was made on them during many years; and it seems probable that as the oil pools have been exhausted of the larger portion of their contents, so we may expect to finally exhaust the largest gas-pool which has yet been reached. Fortunately, the great thickness of the strata, and the frequency of the occurrence of porous masses in them, suitable for the storage of gas, seems to promise a long-continued supply in those regions, such as Western Pennsylvania and Ohio, where the strata have been but little disturbed. Mr. Peter Neff, of Cambia, Knox County, Ohio, asserts that his *Well No. 2* has been systematically examined during the last fourteen years, and there has been no apparent diminution in the supply during that time, and that the well has been *blowing* during twenty years. Instances of this kind are not infrequent, and have given rise to the theory, supported by Mr. Lorin Blodgett and others, that the hydro-carbons are being distilled now, in vast quantities, at the proper depth below the level of the ocean, and are constantly re-supplying these natural reservoirs through the same avenues by which they have heretofore been filled.

It may be remarked, in passing, that we are beginning to approach the economy of nature in the production of fuel gas; and were the supplies, which are supposed to have been derived from the shales and stored for use in the sandrocks above them, to be completely exhausted, we would be able to substitute therefor a gaseous fluid, for a price quite within the purchasing power of manufacturers.

The search for natural gas, and its exploitation, is being conducted with wonderful vigor. In Western Pennsylvania alone there are incorporated fifty-two Natural-gas companies; perhaps others, the names of which have not been noted. The other Western States are following suit, and there seems to be great promise that Kentucky, Ohio, Indiana, Illinois and Missouri, and perhaps Wisconsin, will be supplied from the Natural-gas reservoirs. The Department of the Interior, of the United States Government, reports the total value of the Natural gas produced during the calendar years mentioned, as follows:

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|---|---|
| 1882 | $ 215,000 00 |
| 1883 | 475,000 00 |
| 1884 | 1,460,000 00 |
| 1885 | 4,854,200 00 |

The useful products of Natural gas besides heat and light are, a superior lamp-black, called diamond-black; and, when improperly burned in furnaces, two forms of nearly incombustible carbon; one resembling in appearance Cannel coal, the other more nearly resembling in appearance a very dense coke, from which superior pencils are made for the electric arc-light. The illuminating power of the gas is low, reckoned at eight candles upon the usual scale. There are many systems by which it is enriched with carbon, in order to improve it as an illuminant, chiefly by the use of the lighter products of petroleum; the mixture being converted into a fixed gas by the use of heat and of superheated steam; but the heat evolved in burning it renders the Natural gas unfit for illuminating any but large or open spaces. It is better to use the gas to produce the electric light through a dynamo. The torches of Natural gas make a very good light for yards, rolling mills and streets. The gas has not yet been successfully used in smelting iron-ore; with this exception, it may be used for all purposes for which heat is required, and is superior for those purposes to any other fuel yet known. It is so perfectly subject to control as to quantity consumed, as to distribution in the furnace, or kiln or oven, and is so perfectly free from sulphur or other objectionable admixtures, that it is held by all classes of manufacturers to be beyond comparison the best and most convenient fuel. For the heating of dwellings and for cooking, it is convenient, controllable, cleanly and most comfortable; it soils nothing; there is no dust attends upon it; it may be lighted in an instant, burns equally for as long as wanted, may be increased or diminished in intensity at will, and may be extinguished in an instant; it is always at hand and requires no attention from the consumer to procure a supply after the pipes are laid. It is supplied almost everywhere, where there are organized companies, at a less price than its equivalent in coal.

The engineering problems connected with the search for gas was nearly all solved during the search for oil; and the dangerous physical characteristics of the gas had come to be thoroughly well understood from experience, by explosions and burnings at the oil wells. Some efforts were early made toward the utilization of the gas, as at Fredonia, N. Y., in 1821, and it was piped in small quantities for the lighting of villages, heating of houses, the burning of brick, the manufacture of lamp-black, &c., upon a small scale. For many years before the piping of the high-pressure gas, for the supply of furnaces, rolling mills, &c., was undertaken, it had been known to gas engineers, and to steam engineers also, that the most difficult part of their operations in conveying these fluids from the place of manufacture to the place of use, was to secure the joints of the pipes from leaking. The reports of gas engineers made within the past year or two, indicate that there is still a loss of from fifteen to thirty per cent. of the total production of gas in cities, due to leakage. Mr. Charles E. Emery, in his admirable lecture before the students of Cornell University, gives a similar account of the losses experienced in the transportation of steam.

Mr. George Westinghouse, Jr., had developed the same difficulties in the making of tight joints, in the transportation of air under high pressure. Becoming interested, through the discovery on his land of the most violent gas-well which has ever been struck, in the transportation of that gas for the supply of consumers in the City of Pittsburgh, he gave his attention to the matter of providing the necessary safeguards against the leakage, which he knew to be inevitable and very dangerous, if the gas was to be conveyed at the high pressures, which would alone admit of its cheap transportation over long distances, and of its distribution through such great areas, as were necessary for the supply of that city. He, accordingly, devised and patented several methods of entrapping and carrying away, by escape-pipes, the gas which would leak from the best joints which it is possible to make; perfecting his system by the purchase of the patents of others. This system of escape-pipes employed by the Philadelphia Company, of which Mr. Westinghouse is President, and which is the largest supplier of Natural gas in the world, will be described in this paper, as the most note-

worthy feature in the art of transporting gas, from an engineer's point of view.

*First*, As to Pipes and Joints; the screwed joint upon the wrought-iron pipe, is the best and tightest joint that has been made; yet even this will leak when filled with so ethereal a fluid as gas; and under the pressure of eight or nine pounds to the square inch (or fifteen pounds to the square inch, which is allowed by the ordinances of the City of Pittsburgh), this leakage must be very considerable, and it is likely to be aggravated or increased by the variations in temperature, the settling of the ground in which pipes are laid, and many other occurrences. The screwed joint, however, is not as yet made satisfactory upon pipes of a larger diameter than eight inches; accordingly, for larger wrought-iron pipes than this, up to sixteen inches, the Philadelphia Company uses a leaded sleeve-joint, known as the Converse-joint, reinforced by wrought-iron rings shrunk upon the outside of the cast-iron sleeve. For larger pipes than sixteen inches in diameter, cast-iron pipes are employed, tested to a pressure of three hundred pounds to the square inch; not because they have to resist such an interior pressure, but because pipes of this strength have been found capable of resisting the wear and tear of life under disturbed streets.

In all streets, or near dwellings, the screwed joints of the pipes are each surrounded by a conical heap of broken stone, which is covered by a sheet of heavy tarred-paper, perforated at the top for the admission of a trumpet-mouthed pipe, to collect any gas which enters the heap of stones, which rises a few inches above the heap of broken stones, and communicates with a horizontal line of escape-pipe carried parallel with and over the main gas pipes. This escape pipe is carried, at frequent intervals (say every two hundred or three hundred feet) to a lamp-post in the sidewalk, through which the gas, which has been collected in the escape pipe, is discharged into the open air at a point where it can do no harm. In some instances, these lamp-posts are lighted, to serve as *torches* for illuminating the streets; or they are surmounted by lamps, in which a regulated flame burns continuously, giving light by night, so long as there is any gas escaping from the mains. This arrangement has been found to afford entire security against the leakage from the small lines, which might otherwise have penetrated into adjacent vaults and cellars, where it would form a dangerous explosive mixture, liable to be ignited and to destroy lives and property; as has been shown by much experience in Pittsburgh and elsewhere, before this open means of escape for the gas which leaks from the joints had been contrived. The piles of broken stones, provided with an escape-pipe, as described, collect much other gas than that which leaks from the pipes or joints, for which they are prepared as a security; almost always taking up quantities of illuminating gas from the ground, especially when the surface is frozen, so that the porosity of the soil of the streets is destroyed. In other joints than those of the screwed pipe, the safety device employed is a casing around the joint to be protected, forming a chamber in which is collected all the gas which may leak from the joint; the leaking gas being led from this chamber up to a line of escape pipes by a small tube, screwed into the casing and communicating with the chamber surrounding the joint; each joint is thus put in communication with an escape-pipe, which is divided into sections from two hundred to three hundred feet in length, and discharged into the air by a pipe connecting it with a lamp-post in the side-walk. From each joint, the vertical pipe continues by a (cross) above the horizontal escape-pipe to within a few inches of the surface of the street, where it is surmounted by a cap, by unscrewing which each joint can be examined as to the amount of its leakage, with the smallest possible disturbance of the road-bed; so that if any lamp-post is found to yield gas in considerable quantity, it is very easy to determine at which joint the leak occurs; and the leak may generally be remedied by filling the casing, around the joint, with a liquid preparation of asphaltum under pressure, which enters the interstices of the lead joint, and solidifies there. The residue may afterward be pumped out of the chamber, leaving it prepared to receive any leaking gas, as before. Inasmuch as the casing itself may leak some gas into the surrounding earth, because of the imperfections in its joining to the main pipe, heaps of broken stone are placed around these casings, covered by tarred-paper, and surmounted by the trumpet-mouthed collecting pipe, which communicates with a second line of escape-pipe, led off, like the other escape-pipes, at frequent intervals, to lamp-posts in the side-walks. It will be seen that for the larger pipes, two lines of escape-pipes are provided in order to insure open passages to the air, for gas that may leak from the joints of the pipes, or from the joints of the casings surrounding the principal joints of the main pipes. The cast-iron pipes are made with a "bowl and spigot-joint," and are provided with a second bowl, outside of the ordinary bowl, which is converted into a casing surrounding the ordinary lead joint of the first bowl, by the insertion of a ring around the pipe in the outer bowl, which leaves a cavity or chamber surrounding the lead joint; the outer portion of the second bowl being filled with a preparation of asphaltum, which is found to be better, cheaper and more convenient than lead for this purpose. The leaking gas is received into the chamber thus formed between the inner and outer joints and conducted away by escape-pipes, after the manner of the other joints described. The leakage from the joint in the outer bowl is always provided for (as are all external joints in this system), by surrounding it with a heap of broken stone covered with tarred-paper, from which an escape-pipe leads to a lamp-post in the side-walk, as before described. These heaps of stone also gather and discharge into the escape-pipes any gas which may issue from an imperfection in the body of the pipe.

The delivery to houses of gas under such high pressure, as is carried in the main pipes, would be very dangerous; and two methods have been employed for lessening the pressure of the gas in the houses—one by the ordinary tank system, in which one tank governs the pressure carried in a large extent of low pressure lines in the streets and in the houses; the other, which has been adopted by the Philadelphia Company, makes use of a separate regulator for each dwelling or consumer; these regulators being so arranged that they will reduce the pressure in the house or service line, which supplies the fires, to not exceeding that of a column of about four inches of water. They are so contrived that, in case an interruption occurs in the supply from the main line, a valve closes, which will not open again, so long as a cock or any other opening exists in the house lines; thus affording a great security against a neglect to close the cocks at the fires in case of an interruption of the supply, and serving as a detector of bad fittings in the house line. The system of supplying consumers through the individual regulator has

many features to recommend it over the method of supplying by tanks; a large number of consumers being always dependent upon the working of a tank, whereas only one consumer depends upon the working of a regulator.

A brief account of the principal features of the Philadelphia Company's system of mains is necessary to complete a view of the most advanced engineering in the transportation of fuel gas. The Company derives its supply from three sources. At Tarentum it has eleven wells; at Murrysville and Lyon's Run, fifty-four. During the year, the wells have been *shut in*, as it is called, by suspending to the casing of each a platform loaded with stone and earth, of a sufficient weight to overcome the pressure in the wells, which amounts to about five hundred pounds per square inch. The gas therefore is no longer allowed to be wasted by blowing off into the air, when not required by consumers; but is retained in the natural reservoir. It was found necessary to provide cast-steel fittings at the tops of the wells; the ordinary cast-iron fittings not being strong enough to resist the interior strain.

There are thirteen lines of pipes belonging to the Philadelphia Co. reaching the City of Pittsburgh, the lengths of these varying from seventeen to twenty-four miles from the wells to the City Hall. These several lines are inter-connected by cross-lines at several points throughout their length, and begin to ramify at the city limits, sending off large arteries to each portion of the City; from which main arteries smaller ones distribute the fluid through all the considerable streets of the Cities of Pittsburgh and Allegheny, and their suburbs. At the wells, the pipe connections are so arranged that the product of any well may be availed of to increase the pressure in any one of the several lines, so that several wells may be shut off from any part of the system and their places supplied by others, securing any required pressure, upon any line, at all times, It is believed that this Company was the first to adopt the telescopic arrangement for its pipes, increasing them in diameter at intervals on the way to the place of comsumption, so as to be able to deliver a volume of gas at a designated pressure. The usual mode of laying gas mains has been to lay a pipe of uniform dimensions, no matter how long the line, submitting to a loss in both volume and pressure, according to the law of decrease in a uniform tube. In designing the Philadelphia Company's system, care was taken to avoid all dead-ends, and to provide frequent connections between all the main arteries of the system, so that the gas could be carried around in many circuits; and when it becomes necessary to shut off any portion of a main, only the smallest number of consumers will be affected thereby; indeed almost any repairs or changes may be made upon these lines without interrupting any consumer; for, if the gas cannot reach him from one direction, it will reach him from the other. The main lines are provided at their intersections with convenient stations, supplied with gauges attached to each of the lines; with governing valves, and with automatic safety valves, so that the pressures cannot accumulate above a certain tension. There are twenty-one of these stations, at which agents are in attendance night and day, and control the pressures in each section of the pipes, according to the directions communicated by telephone from the office of the General Superintendent; the variations in the consumption on the different lines, making changes necessary from hour to hour, or sometimes, as often as every quarter of an hour. Of course, the automatic safety valves provide against any dangerous accumulation of pressure; but it is desirable not to waste the gas, and to maintain a proper flow in the pipes in accordance with the consumption at the moment. It is expected to provide automatic regulators for this purpose; but at present, human agency is employed, as has been said.

It will have been seen from the foregoing, that the same concern for the protection of human life and for safety from accident, which led Mr. Westinghouse to the invention of the air-brake, has characterized his engineering in the construction of the great system of the Philadelphia Company, which has been so imperfectly sketched. To the writer, his early association with the foremost Company for the transportation of this new and dangerous gas seems a fortunate conjunction, for the people among whom he dwells—which may be called providential.

The bibliography of Natural gas is more extensive than is generally supposed, because the papers are scattered through the proceedings of many societies and through the volumes of geological surveys. The most important papers, because the authors are the most familiar with the subject, are those by Professors Leslie, Ashburner, Carll and White, in the geological surveys of Pennsylvania.

Mr. Ashburner has written several other papers on the geologic distribution of Natural gas, and the oil fields, which form a part of the same subject, printed by the American Institute of Mining Engineers. Mr. McMillan, President of the Ohio Institute of Mining Engineers; Mr. Edward Orton, State Geologist of Ohio; Mr. W. P. Shinn; Mr. Jos. D. Weeks, of the *American Manufacturer and Iron World*, of Pittsburgh, Pa.; Mr. Lemuel Bannister, in a valuable pamphlet entitled "Something About Natural Gas;" Mr. Lorin Blodgett, in *Bradstreet's;* Mr. S. A. Ford, of Pittsburgh, and Mr. F. W. Taylor, in proceedings of the American Society of Mechanical Engineers.

Prof. Newberry, of the School of Mines, and Mr. T. Sterry Hunt, of the Canadian Geological Survey, were among the earliest investigators of the origin of oil and gas.

There is much else which might be referred to, but these references will open up the subject to those who wish to pursue the inquiry in a serious manner.

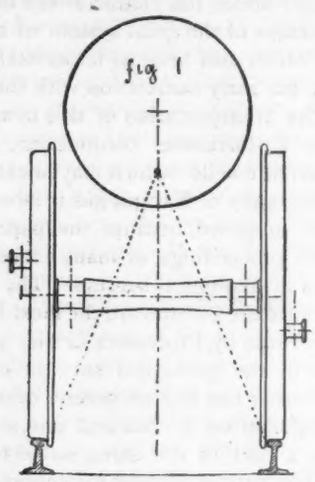
## High or Low Center of Gravity in Locomotives.

(From *The Mechanical World.*)

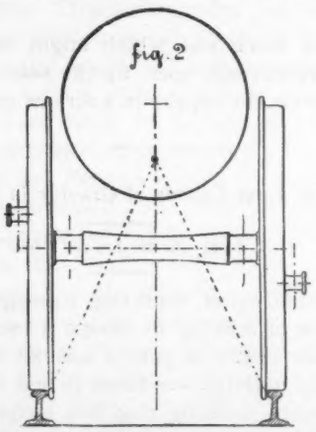
The present writer, venturing to suggest recently that the practice of seeking to design a locomotive so as to obtain a low center of gravity was not only unnecessary but actually harmful, was taken to task for so doing, and now purposes showing that his contention was right, quite apart from its practical demonstration at the hands of those whose duty it is to drive locomotives. Perhaps the chief advantage of a high center of gravity, which is in the main determined by the elevation of the boiler, lies in the diminished effect of lateral blows of the wheel flanges upon the rails. All locomotives in running are more or less liable to these sudden lateral movements which result in very severe blows upon the rails. The difference of action in such cases between an engine with

a high and one with a low center of gravity may be gathered from Figs. 1 and 2.

From a consideration of these two figures, it is easy to see that in the case of the high boiler, any lateral displacement of the wheel flanges at their lowest points—viz., the rail level—is very much less directly transmitted to the center of gravity of the whole machine than is the case with the boiler in Fig. 2. This is due of course to the greater distance of the weight from the rail, assuming, which may fairly be done for comparison, that the whole weight is concentrated at the respective centers of gravity. In the case of the high boiler, the lines of




action—as shown by the dotted lines—pass nearer to a vertical through the springs; and hence these serve to transmit, or rather we should say absorb, shock better than they can possibly do when the center of gravity is lowered. Assuming, for the sake of argument, that the center of gravity could actually be brought to the rail level, a consummation much striven toward not many years ago by some designers, it is by no means difficult to see that the whole mass of the machine in moving laterally would act directly with great severity on the rails, all spring action being absent. Every inch of elevation of the boiler, therefore, brings into action more of the ab-




sorbing action of the springs and reduces the shocks and tremors of a running engine, and the centrifugal action in taking a curve assists in bringing upon the outer rail that excess above the load on the inner rail, which is desirable, and which is sought for in the design of the Bissel bogie or the swing beam; and yet with any reasonable elevation of boiler the action does not approach dangerously near to an overturning point.

A point much overlooked, or perhaps not at all considered in the design of locomotives, is the possibility of the time of oscillation of the engine synchronising with the period of the cause of transverse oscillation. Such a cause was shown in the *Mechanical World* of November 12th, in the inclined position of outside cylinders especially, and the synchronism would be most severe at a certain forward velocity of the engine, less so at half or double this same velocity, and still less at velocities giving no immediate ratio of wheel revolution to period of vibration. To ascertain the probabilities of any special engine, the height of the center of gravity above the center of oscillation would require finding, in order to determine the period of transverse vibration. Such period would best be found by experiment with an actual engine slightly altered in the springs. Knowing this period and the wheel diameter, it could then easily be ascertained what speed in miles per hour would make the wheel revolutions or half revolutions coincide with oscillations of the engine as a pendulum. Should such be the case at the speed for which the engine is desired generally to run, it would be necessary to alter the wheel diameter, to change the rate of impulse, or raise the boilers in any other engines afterward made, so as to alter the "pendulum length."

It would not be difficult so to design an engine, that at any speed the center of gravity could be raised or lowered, if it appeared that synchronism existed at such speed.

The simple turning of a cock by the driver could be made to vary the center of gravity sufficiently to cause steadiness. That such a refinement is necessary may well be doubted, but it is well to know that its attainment is a simple matter, and it is well also to recognize that a variation in the position of the boiler, the diameter of the wheels, or the position of springs and length of spring links, etc., all have a direct and immediate effect on the running qualities of a locomotive in other respects than those generally credited to these details.

## Pipe Lines on Sugar Plantations.

OWING to the hot climate of Queensland, it is said to be absolutely impossible to conduct the work of the sugar plantations with white labor and find the industry profitable. To get over this difficulty, a scheme has been tried, to a limited extent, by which the manufacturing processes of making sugar are carried on at a central refinery owned by separate proprietors, or by the different cane growers. According to this scheme, the farmers are to confine themselves personally to cane growing on a moderate scale. In one case, the farmers possess their own rolls, and the juice only is carried into the factory, which is fed from twenty-five separate mills. The juice, after being charged with lime to prevent acidity, is conveyed to the factory either by road or river; but by far the most important manner of transit is by means of an extensive system of 3-inch underground pipes. These have been laid between the various mills and the central refinery, and through them the juice is forced for miles by powerful pumping-engines. The amount of juice treated in this refinery amounted in 1885 to over ten million gallons. The price allowed is £15 a ton; but this, the farmers say, is too low, and that they would get more for their produce were the factory subject to competition. Near the town of Bundaberg, there is a somewhat similar system in operation, a gigantic refinery having been erected at Millaquin.

## PERFORMANCE OF A PUMPING ENGINE.

BY JOHN W. HILL, M. E.

THE Gaskill pumping engine recently constructed by the Holly Manufacturing Company, of Lockport, N. Y., for the city of Kalamazoo, Mich., presents so many novel features of construction, and withal has developed such an excellent economy for its dimensions, that a review of the machine and the results obtained upon test trial is considered of sufficient value to justify the following paper.

The engine is vertical, compound condensing, provided with a beam crank and two fly-wheels, with the steam cylinders mounted upon a heavy cast-iron housing over the pumps.

The pumps are of the single-acting plunger variety with outside stuffing-boxes, of similar diameters and strokes of plungers; placed in a vertical position three feet five inches from center to center; one plunger being driven by the high-pressure steam piston, and the other by the low-pressure steam piston.

The engine-beam centers turn in bearings in the housing, which are located centrally between the center lines of the high and low-pressure steam cylinders, and about midway between the steam cylinders and pumps. The beam is elliptical in elevation, of two steel-rolled plates, each 1.25 inch thick, 48.5 inches deep at the center, and 46.5 inches from center to center of end pins. The two plates are riveted at the center to a heavy, central cast-iron boss through which the shaft passes, and is provided with cast-iron bosses, riveted on, to form bearings for the working pins. The pin taking the inner end of the main connecting-rod is set 23.25 inches from beam center, and below the pin which takes the lower end of the link of the low-pressure piston.

The crank-shaft is bent at the center to form a pin or journal for the outer end of the main connecting-rod, and overhangs the housing on each side, with a fly-wheel keyed on each end. The bearings for the crank-shaft are set off to one end of the housing and the driving-pin in the working beam set tangential to the crank-pin and shaft bearings, when the crank is on the centers, and the steam pistons and plungers at the ends of stroke.

The bearings and crank journal on the shaft are of similar diameters.

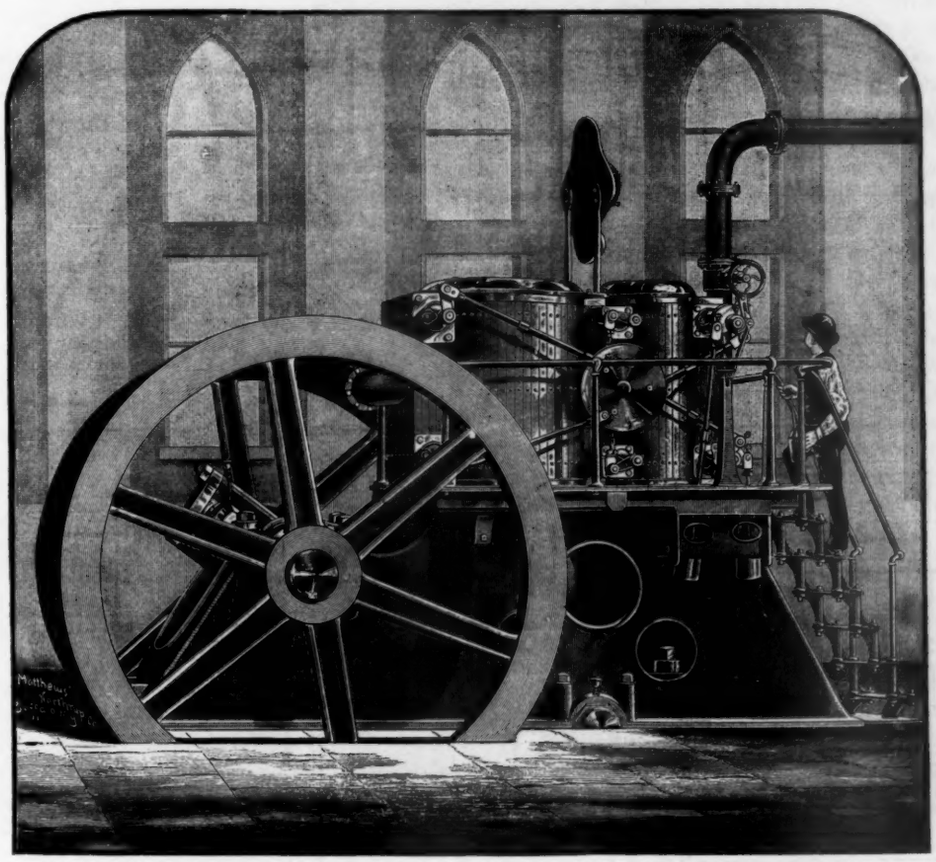


Fig. 1.

The steam cylinders and heads are steam jacketed, the condensation from the jackets and any surplus steam being trapped back through a closed feed-water heater to the boiler feed pump, from which it is returned to the boiler. (The construction of the jacket drainage and feed-water apparatus is such that a loss by a large flow of steam through the jackets is balanced by a corresponding increase in the temperature of feed-water to boilers, less any losses by conduction and radiation through connecting pipes, which probably would be less than the loss of economy which might occur with an inadequate supply of steam to the jackets.)

The engine housing is bolted to a foundation which rises about 2.5 feet above the floor of the engine room, and the sole plate of the pumps is bolted to the foundation, about 8 feet 4 inches below the floor line.

The entire arrangement of steam and water ends and crank-shaft is as compact as possible, only such spaces

existing as are absolutely necessary to the action or adjustment of the working parts.

The steam valves and gear are of the Corliss pattern, one wrist plate working from five pins the two steam-valves, of the high-pressure cylinder, the two intermediate valves between the steam cylinders and the two exhaust-valves to the low-pressure cylinder. The steam-valves are of the automatic liberating kind, the point of cut-off being adjustable by hand and by the automatic pressure-regulator, which governs the cut-off according to the head against which the pumps are working. The intermediate and exhaust-valves have fixed motions.

| | |
|---|---|
| Stroke, steam pistons [nominal] | 30.0 inches. |
| High-pressure piston-rod [1] diameter | 2.625 " |
| Low-pressure " " [2] " | 3.4275 " |
| Clearance, high-pressure cylinder, estimated | 2.5 per cent. |
| " low-pressure " " | 2.5 " " |

Steam cylinders, jacketed sides and heads, with sides lagged, with walnut staves, and upper heads finished with polished covers.

| | |
|---|---|
| Crank-shaft, diameter, journals | 12 inches. |
| Crank-pin " " | 12 " |
| Fly-wheels, [two] diameter | 10 feet. |
| " " " weight [each] | 8,000 pounds. |

Air-pumps (two), single acting, bucket pattern, worked

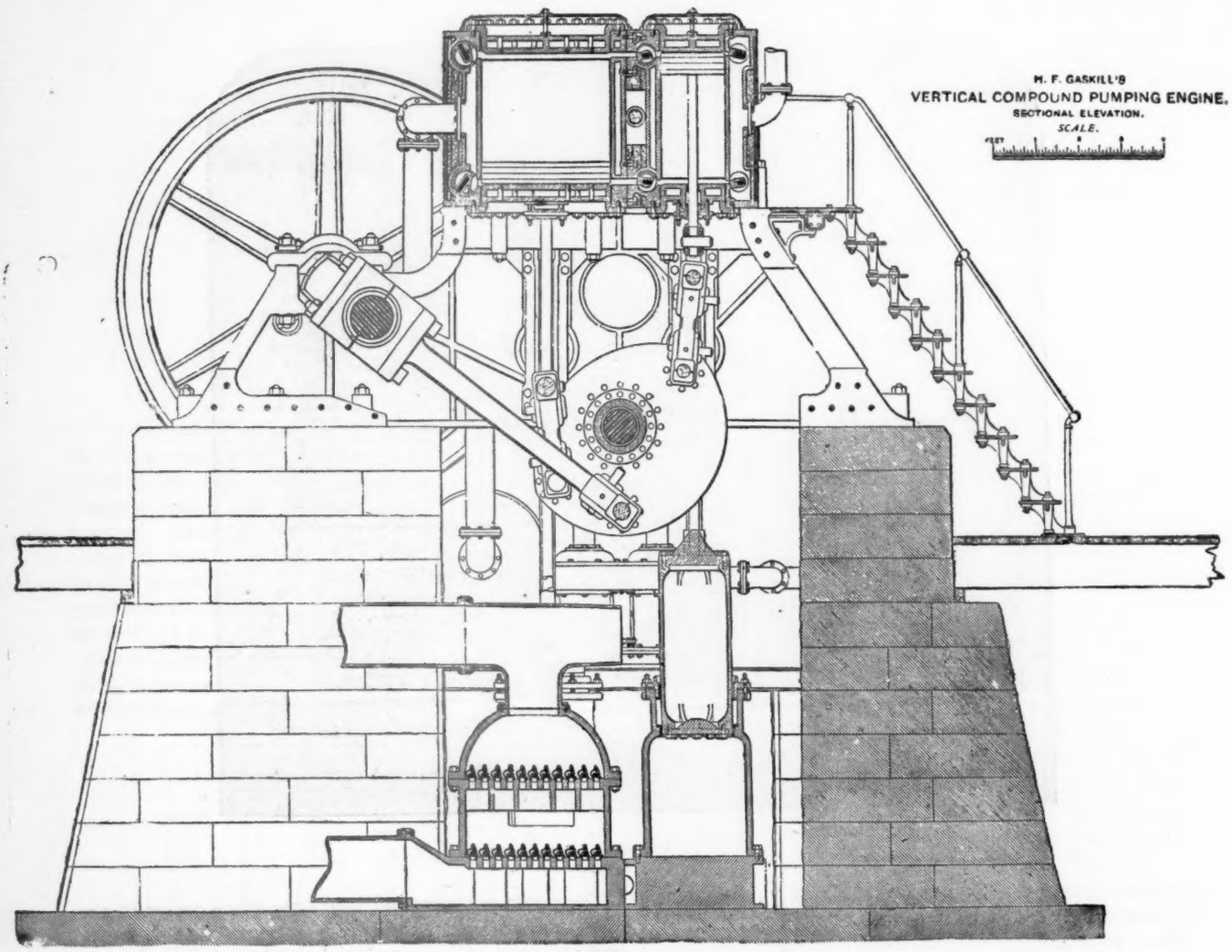



Fig. 2.

The condenser is of the jet variety, taking injection water from the suction pipe of the main pumps.

In the following table are given the principal dimensions of the engine, and arrangement of the principal details. (The pump plungers were carefully measured previous to the trial.)

| | | | |
|---|---|---|---|
| Plunger driven by high-pressure piston, | | diameter | 20.03125 inches. |
| " " " " " " | | stroke | 29.96875 " |
| " " " low-pressure " | | diameter | 20.03125 " |
| " " " " " " | | stroke | 29.922 " |

The other principal dimensions of the engine were taken from contractors' drawings, except steam piston-rods, which were measured.

| | |
|---|---|
| High-pressure steam cylinder, diameter | 18.0 inches, |
| Low-pressure " " " | 36.0 " |

from pins at ends of an even lever, working beam mounted on an extension of the engine-beam shaft.

| | |
|---|---|
| Air-pumps, diameter | 11 inches. |
| " " stroke | 14 " |

Boiler feed-pumps are of the single-acting plunger variety, two in number, worked from an even lever beam keyed on the extension of engine-beam shaft, outside the beam, by which the air-pumps are driven.

| | |
|---|---|
| Feed-pumps, diameter | 3 inches. |
| " " stroke | 7.25 " |

Pumps are fitted with four sets of small single beat rubber valves, mounted in composition shells, and working on composition seats screwed into the diaphragm of valve chambers.

Each set contains 91 valves, or 364 valves in the suction and discharge chambers of both pumps.

| | | |
|---|---|---|
| Pump-valves, diameter disc | 1.75 | inches. |
| " " " opening in seat | 1.3125 | " |
| " " lift | 0.3125 | " |
| " " thickness of disc | 0.50 | " |

The valves are guided above the seat by the stem (which moves with the disc) passing through a hub in a three-winged cage, which screws down over a threaded projection of the seat, outside the valve disc.

The lift of pump-valve presents a clear opening between the disc and seat of 1.718 square inches, while the area through the seat is the full area for diameter—or 1.353 square inches. The velocity of flow through the seats, with plungers moving at the rate of 130 feet per minute:

$$\frac{130 \times 315.1425}{123.123 \times 60} = 5.547 \text{ feet per second.}$$

The pumps take water from a curbed well, outside pump house, 20 feet diameter, 25.8 feet deep from coping. The well is supplied by infiltration through the surrounding soil, which passes under the iron shoe upon which the tight curb is built.

The specification and agreement provided that the engine should have a daily capacity of 3,000,000 United States standard gallons of water, at 120 feet piston speed, against a domestic head of 120 feet; should be capable of pumping against a fire pressure of 130 pounds per square inch of pump plungers, with 70 pounds steam pressure by gauge, and should develop a duty of 95,000,000 foot pounds per 100 pounds of best coal (to be selected by the contractor) burned under the boiler, with steam pressure at 70 pounds by gauge.

The contract trial was conducted in accordance with the specification and agreement between the City of Kalmazoo and contractors, and the usages and rules generally accepted in test trials of pumping machinery of the first class.

Previous to the trial, levels were taken of the center of water-pressure gauge from which the pressures were read, of the center of the pumps, and of a bench mark located in the pump well, from which the stages of water in the well during the trial were taken by means of a Chesterman tape and float.

The vertical distance from the center of water-pressure gauge to the center of pumps is 20.48 feet. From center of pumps to average level of water in pump well, during duty trial, was 14.4463 feet. From center of water-pressure gauge to B. M. in pump well was 18.000 feet.

For duty trial the following data were taken:

| | | |
|---|---|---|
| Steam pressure at boiler | every 15 | minutes. |
| " " " engine | " 15 | " |
| Water pressure | " 15 | " |
| Engine counter | " 15 | " |
| Level of water in boiler | " 15 | " |
| Vacuum in condenser | " 30 | " |
| Level of water below B. M.—in pump well | " 30 | " |
| Temperature of feed-water to boilers | " 30 | " |
| " " injection to condenser | hourly. | |
| " " overflow from air-pumps | every 30 | minutes. |
| " " air in engine room | hourly. | |
| Indicator diagrams from steam cylinders | " | |
| Barometer | " | |

The coal burned was "Lackawanna," of good quality. This was weighed in uniform charges of 70 pounds, on an acceptable scale in the boiler room, at the rate of two charges an hour, and dumped, just previous to firing, in front of the boiler; only one charge at a time being allowed upon the floor.

The fire was worked right and left; 70 pounds to a charge, every 30 minutes.

At 11 A. M., March 9th, the half fire to the right received the first full charge of 70 pounds; at 11.30 A. M., the half fire to the left received the second full charge of 70 pounds. At 12 M., the half fire to the right received the third full charge of 70 pounds; at 12.30 P. M., the half fire to the left received the fourth full charge of 70 pounds, and in like manner throughout the trial, the half fires right and left being alternately fired with regular intervals of 30 minutes between the firings.

At 5.15 A. M., March 10th, an extra charge was divided between the right and left side of fire; at 10.45 A. M., an extra charge was divided between the two sides of fire.

The trial for duty commenced at 11 A. M., March 9th, and ended at 11 A. M., March 10th, embracing an uninterrupted operation of the engine, under nearly uniform conditions of steam pressure, water pressure and speed—for a period of 24 hours.

During this time the coal fired was 50 charges of 70 pounds, or a total consumption of 3,500 pounds. Ash, clinker, and waste from ash-pit, at end of trial, 158.5 pounds. Percentage of non-combustible, 4.53 pounds.

The grate-bars were of the rocker pattern, and these were worked frequently to clear the fire of clinker and ash during the trial. The fires were cleaned of ash and clinker at beginning of trial, and the ash-pit raked clean. The fires were of the same thickness and in same condition, as nearly as could be judged from careful observation, at beginning and end of trial. The condition and thickness at beginning was observed and entered in the writer's notes at the time, and the same condition and thickness was restored at the end of trial.

The average head pumped against during the trial was 59.8384 pounds, obtained as follows:

| | | |
|---|---|---|
| Average pressure by water-pressure gauge | 42.7057 | pounds. |
| Correction of gauge | 1.0000 | " |
| Corrected gauge pressure | 43.7057 | " |
| Center of water-pressure gauge to bench mark | 18.0 | feet. |
| B. M. to surface, water in well | 16.9263 | " |
| Pressure due different levels | 15.1327 | pounds. |
| Add allowance for frictional resistance of pumps | 1.000 | " |
| Total head | 59.8384 | " |
| " " | 138.106 | feet. |
| Engine counter, 11 A. M., March 9th | 149,986 | |
| " " 11 A. M., " 10th | 188,188 | |
| Revolutions in 24 hours | 38,202 | |
| " per minute | 26.5292 | |
| Piston speed, per minute, feet | 132.407 | |

Area of plungers, (each)

$$20.03125^2 \times 0.7854 = 315.1425 \text{ square inches.}$$

Plunger travel, per revolution of engine,

$$\frac{29.96875 + 29.922}{12} = 4.991 \text{ feet.}$$

And duty developed, per 100 pounds of coal,

$$\frac{315.1425 \times 4.991 \times 59.8384 \times 38202}{35.00} = 102,728,884.96 \text{ ft. lbs.}$$

The specification and agreement guaranteed a duty of 95,000,000 foot pounds per 100 of coal burned, which was exceeded in the actual performance of the engine by nearly *eight millions* foot pounds.

The means of the data taken during the duty trial are as follows:

| | | |
|---|---|---|
| Duration of trial | 24 | hours. |
| Pressure of steam at boiler | 72.062 | pounds. |
| " " " engine | 71.287 | " |
| Level of water in boiler, 11 A. M., March 9th | 7.00 | inches. |
| " " " " " 11 A. M., " 10th | 6.875 | " |
| " " " " " mean for trial | 7.0332 | " |

| | |
|---|---|
| Vacuum in condenser, observed | 25.863 inches. |
| " " " corrected | 24.345 " |
| " " " " | 11.951 pounds. |
| Temperature of feed-water, observed | 171.344 |
| " " " " corrected | 168.344 |
| " " injection, observed | 50.937 |
| " " " corrected | 49.937 |
| " " overflow, observed | 93.156 |
| " " " corrected | 91.656 |
| " " air, engine room | 73.23 |
| Barometer, inches | 29.466 |
| " pounds | 14.465 |

It was provided by the specification and agreement, that the engines hould have a capacity of 3,000,000 United States standard gallons per diem of 24 hours, at a piston speed of 130 feet per minute.

No provision was made in the contract for the measurement of the delivery of the pumps; neither were the connections of the pumps with the source of supply and the distributing mains such that an accurate measurement of the delivery could have been made, except with a discontinuance of water to the city for a period of several days.

In the absence of an exact measurement of the delivery of the pumps, which was not provided for by the contract, the writer measured the diameters and strokes of the pump plungers, from which to deduce the probable actual delivery at contract piston speed.

The pump plungers were carefully calipered, and measured upon a Brown & Sharp standard 24-inch steel scale, with results previously given in the table of dimensions. The stroke of plungers was measured by holding a finely pointed lead pencil firmly upon the upper surface of the lower cross-head (of each side of engine), which was machine faced, and causing it to inscribe the lineal movement of the pencil, and, by the same token, of the cross-head and connected plunger upon a dressed pine board held firmly down upon the top of pump-barrel and parallel with the axis of plunger, with the results previously given in the table of dimensions,

The total plunger stroke, per revolution of engine, was 59.89075 inches; and calculated capacity of both pumps, per revolution of engine, equal to one stroke of each pump, or two single strokes of plungers,

$$\frac{20.03125^2 \times 0.7854 \times 59.89075}{231} = 81.706 \text{ gallons.}$$

The pumps being of the single-acting variety, the effective area was therefore the full area due the diameters of plungers, or, 315.1425 square inches, and capacity of pumps, per diem of 24 hours, at a piston speed of 130 feet per minute,

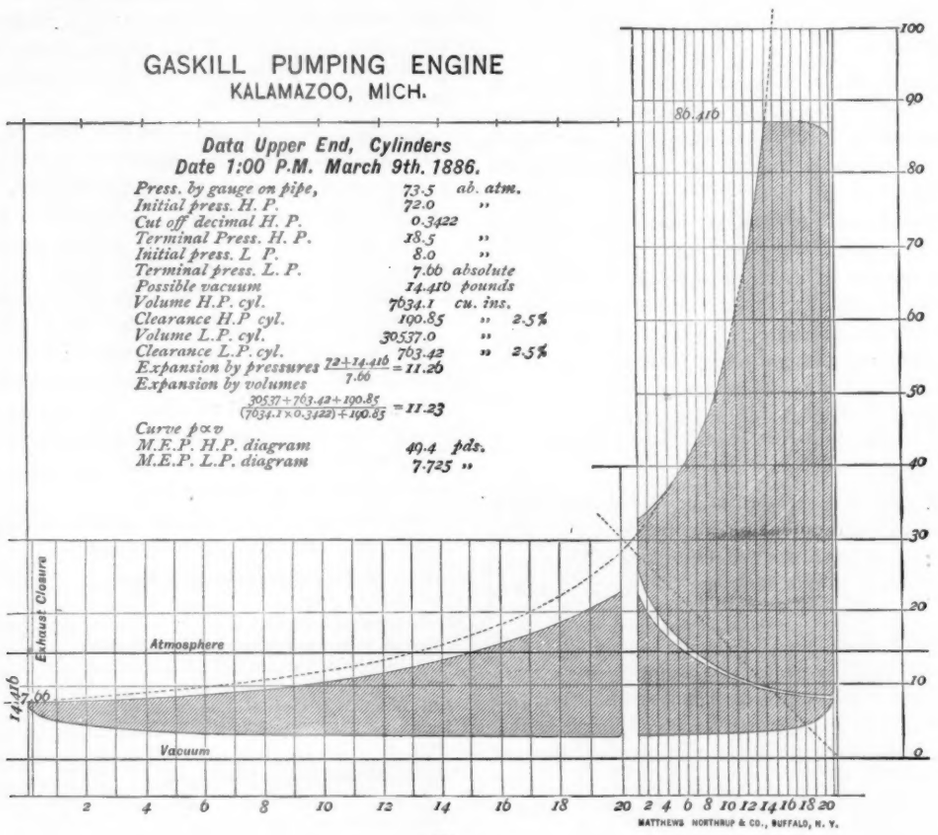



Fig. 3.

$$\frac{315.1425}{231} \times 12 \times 130 \times 1440 = 3{,}064{,}658.69$$

United States standard gallons.

The contractors' guaranteed capacity per diem, at 130 feet piston speed per minute, was 3,000,000 gallons. The calculated capacity of the pumps per diem, from measured dimensions and at 130 feet piston speed per minute, is 3,064,658.69 gallons, allowing 64,658.69 gallons, or 2.1098 per cent. of calculated capacity to cover the loss of action or slip of pumps.

Although this loss of action was less than the writer had ever obtained from comparison of calculated plunger, or piston displacements of pumps, with the actual measured deliveries, still it was not without precedent, as shown in the following test trials of pumping engines:

Simpson compound beam-rotative pumping engine, built by E. P. Allis & Co. for the City of Milwaukee, 1875, bucket and plunger pump:

Loss of action, 2.26 per cent.

Worthington compound, duplex, direct-acting pumping engine, built by H. R. Worthington for the City of Lowell, Mass., 1876, double-acting plunger pumps: Loss of action, 2.25 per cent.

Worthington compound, duplex, direct-acting pumping engine, built by H. R. Worthington for the City of Philadelphia, 1872, double-acting plunger pumps: Loss of action, 1.50 per cent.

Wm. Wright single cylinder, beam-crank and fly-wheel pumping engine, No. 1, Brooklyn Water Works bucket and plunger pump, from tests by Mr. Kirkwood, 1860: Loss of action, 2.0 per cent.

Wm. Wright single cylinder, beam-rotative pumping engine, No. 2, Brooklyn Water Works bucket and plunger pump, from tests by Mr. Kirkwood, 1860: Loss of action, 1.50 per cent.

Corliss compound crank and fly-wheel pumping engine, built by Corliss Steam Engine Co, for the City of Providence, R. I., 1882, single-acting plunger pumps: Loss of action, 0.50 per cent.

Mr. Colyer, in his "Treatise on Pumping Machinery," page 84, says: "The slip of single-acting plunger pumps, Cornish style, at the Southwark and Vauxhall Water Works, London, does not exceed 2 per cent. of the calculated displacement."

Although the least loss of action which the writer has ever measured is greater than any given in the table above, as follows:

Gaskill compound crank and fly-wheel pumping engine, Memphis, Tenn., 1882, double acting plunger pumps:

Engine No. 1. Loss of action, 2.43 per cent,
" No. 2. " " " 2.44 " "

he is of the opinion that the style of pumps furnished with this engine—with the packing around the plungers tight and pump valves in good condition—will work with a loss of action less than was found for the Memphis pumping engines with central packing rings, and that the allowance of 64,658.69 gallons per diem, in excess of the contract capacity of 3,000,000 gallons, will fairly cover the probable loss of action of the pumps, and that the contract requirements for capacity were fairly complied with.

It has been stated that the well from which the engine pumps, is supplied by infiltration from the surrounding soil, which passes into the well under the iron shoe upon which the curb is built.

(*To be continued.*)

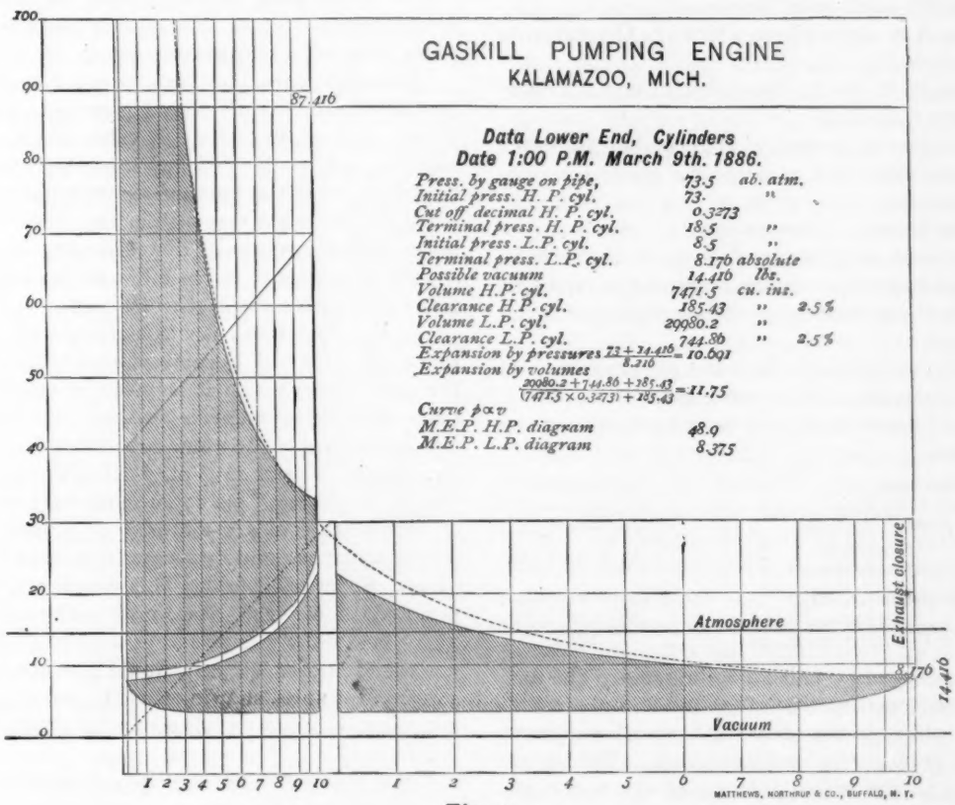

GASKILL PUMPING ENGINE
KALAMAZOO, MICH.
Data Lower End, Cylinders
Date 1:00 P.M. March 9th. 1886.
Press. by gauge on pipe, 73.5 ab. atm.
Initial press. H. P. cyl. 73. "
Cut off decimal H. P. cyl. 0.3773
Terminal press. H. P. cyl. 18.5 "
Initial press. L.P. cyl. 8.5 "
Terminal press. L.P. cyl. 8.176 absolute
Possible vacuum 14.416 lbs.
Volume H.P. cyl. 7471.5 cu. ins.
Clearance H.P. cyl. 185.43 " 2.5%
Volume L.P. cyl. 29980.2 "
Clearance L.P. cyl. 744.86 " 2.5%
Expansion by pressures 73+14.416/8.176 = 10.691
Expansion by volumes (29980.2+744.86+185.43)/(7471.5×0.3773)+185.43 = 11.75
Curve pαv
M.E.P. H.P. diagram 48.9
M.E.P. L.P. diagram 8.375
87.416
Atmosphere
Exhaust closure
8.176
14.416
Vacuum
MATTHEWS, NORTHRUP & CO., BUFFALO, N. Y.

Fig. 4.

## Locomotive Coupling-Rods.

THERE have been several letters published in English engineering papers, recently, containing testimony with reference to the first use of solid eyes and bushes on locomotive coupling-rods. The latest writer says: "The first coupled locomotive with *solid eyes and bored and turned bushes* I had seen, was made by the firm of Slaughter, Grunning & Co., of Bristol, turned out early in 1861, to the order of the Waterford & Tramore Railway Company, and it was considered a new departure at the time. Can some of your other correspondents give an earlier date?"

It may interest some of these correspondents to know that solid eyes and bushes were used in this country on Winans' camel engines as early as 1852. They are also shown in an old lithograph of a "grasshopper" locomotive built by Gillingham & Winans in 1835.

## Is Water Gas an Economical Fuel?*

BY WILLIAM KENT, NEW YORK.

IN the discussion of Mr. F. W. Taylor's paper on water gas, at the Chicago meeting, the writer stated that the conclusion to which Mr. Taylor had been led by his experiments, viz.: that water gas is not as economical as Siemens gas, when used as a fuel for steel-melting furnaces, would probably be confirmed by a theoretical consideration of the amount of heat carried away in the chimney gases. A further study of the subject shows that the opinion then given was correct.

Let C represent the carbon in a given quantity of fuel.

O the oxygen needed to make carbonic oxide (CO) with this C.

2O the oxygen needed to make carbonic acid ($CO_2$) with the same C.

$H_2O$ the water needed to make water gas of the formula (CO+2H) with the same C.

N the nitrogen in the air from which the O is taken to burn C to CO.

2N the nitrogen in the air from which the 2O is taken to burn C to $CO_2$.

Ex. air the excess of air used in final combustion in the furnace over that required to make complete combustion.

The fuel may be used in three ways:

1st, by direct and complete combustion in the furnace.

2d, by partial combustion in the Siemens gas producer, and final combustion of the Siemens gas in the furnace.

3d, by partial combustion in the water gas producer, and final combustion of the water gas.

The results of the three ways of burning the fuel are as follows:

| | | Materials used. | Products. |
|---|---|---|---|
| 1. | Direct. | C+2O+2N+Ex. air | $CO_2$+2N+Ex. air. |
| 2. | Siemens. | In producer, C+O+N | CO+N (Siemens gas). |
| | | In furnace, CO+N+O+N+Ex. air. | $CO_2$+2N+Ex. air. |
| 3. | Water gas. | In producer, C+$H_2O$ | CO+2H (Water gas). |
| | | In furnace, CO+2H+2O+2N+Ex. air | $CO_2$+2N+Ex. air +$H_2O$. |

The final product of (1) and (2) is the same. The final product of (3) differs from that of (1) and (2) only in containing $H_2O$, which is the same $H_2O$ (water) which was added in the producer in making the gas. This is true whatever may be the actual formula of the water gas. All the water originally used in the manufacture of the gas reappears in the products of combustion in the chimney. The only difference is that in the chimney it appears in the form of steam, superheated to the temperature of the chimney gases, while it originally enters the system as cold water. All the heat contained in the water thus escaping in the chimney, above the amount it contained when it was originally introduced into the system, is entirely wasted.

The amount of heat thus wasted can be calculated if we know the amount of water used, and its temperature on entering and on leaving the system.

Suppose a pure water gas to be of the formula

$$CO+H \text{ made from } C+H_2O$$

or, pounds, 12+16+2 12+18

The escaping gases would contain, in addition to nitrogen and excess of air,

$$CO_2+H_2O$$

pounds, 44+18.

The 18 pounds of water being the same from which the water gas was made with 12 pounds carbon. The carbon, if completely burned from C to $CO_2$, would generate $12 \times 14{,}500 = 174{,}000$ heat units (Fahrenheit). Suppose that the chimney gases are cooled by regenerators or other means down to 212° F., that the water escapes in the form of steam of that temperature—its total heat, including latent heat of evaporation, being 1,178° F.—and that the water entered the system at 78° F. The heat carried away by this water escaping in the shape of steam, in excess of that which it introduced into the system, would be

$$1{,}100 \times 18 = 19{,}800 \text{ heat units,}$$

equal to about 11.4 per cent. of the whole amount of heat produced by burning the 12 pounds carbon from C to $CO_2$.

This is the most favorable case, for it is in practice never possible to cool the chimney gases of heating furnaces to as low a temperature as 212° F.

Theoretical considerations, therefore, indicate a loss of economy in the use of water gas as fuel, equal to at least 11 per cent. of the total fuel value of the carbon used, and this, independent of any loss which may arise from imperfections of the producer or its method of operation.

Such a loss is not met with in the Siemens system, nor in the ordinary system of direct burning of the fuel upon a grate, except in so far as moisture in the shape of cold water may be present in the fuel used.

The fact that there is a loss of economy in the use of water gas as a fuel, in comparison with the direct use of the carbon from which it is made, is clearly revealed in other ways, however, even by some of those who have written in favor of the water-gas processes. For instance, Dr. Henry Wurtz, in Vol. VIII "Trans. Amer. Inst. Mining Engineers," pp. 295, 296, shows that 37.5 pounds of anthracite coal are required to generate 1,000 cubic feet of water gas, and that water gas has a heating power of 311° F. per cubic foot. This equals 311,000 heat units per 1,000 cubic feet. Assuming anthracite to produce 13,000 heat units per pound (a moderate figure), the 37.5 pounds, if burned directly, would produce $13{,}000 \times 37.5 = 487{,}500$ heat units, showing that the water gas has a thermic value of only 63.8 per cent. of the coal from which it is produced.

Better results are deduced theoretically by Mr. Wm. A. Goodyear, Vol. XI "Trans. Amer. Inst. Mining Engineers," p. 311. He shows that water gas derived from anthracite has about 81 per cent. of the heat-producing power of the carbon contained in the anthracite. Neither of the two writers named, however, seem to have considered the cause of the loss of heat to which I have referred, viz.: the carrying away of heat in the superheated steam in the chimney gases.

* Paper read before the American Society of Mechanical Engineers.

## Improvements in Locomotives and Signals.

AT the opening meeting of the session, held on November 9th, Mr. Edward Woods, president, delivered an address, in which he stated that his connection with the profession dated from the time when he entered the service of the Liverpool & Manchester Railway Company. After describing the system on which that line was originally constructed and the improvements subsequently introduced, he observed that, generally, the substitution

of steel for iron rails had been attended with most beneficial results to all railway companies, a change which was rendered possible by the inventions of Sir Henry Bessemer and Sir William Siemens, and the keen competition of manufacturers. The president then proceeded to remark that the most advanced type of locomotives of the present day retained the essential characteristics of those which held the field at the commencement of the era to which he had referred. Great improvements, it was true, had been effected in most, if not in all, constructive details, while the progressive increase of traffic called for a corresponding augmentation of the power necessary to haul the trains. Hence the locomotives of the present day possessed, as a rule, at least four times more steaming power, coupled with six-fold weight, than those of the class represented by the "Planet," the approved type of the period from 1832 to 1836. The contrast in point of efficiency, between the locomotives of the present period and those of half a century ago, was striking. As to tractive power, the increase was at least fivefold, having regard to the proportions of the parts, the steaming capacity of the boilers, and the higher pressures of steam at which the engine was now worked. Inclines which at one time were regarded as too formidable to be worked advantageously by locomotives, were now readily surmounted by the powerful engines of the present day. The limit of inclination admitting of being surmounted by locomotives appeared to be practically reached at the figure of about 264 feet to the mile (one in 20). Where the incline was greater, resort must be had either to the stationary engine and rope, or to one of the systems which had recently been reintroduced. Concurrently with the increase of traffic, the increased speed at which it had to be conducted, and the increased number of trains rendered it necessary to provide fresh agencies. Distant signals were unknown at first, as well as the appliances for controlling them from the home signalman's station. Still later, it became possible to actuate all the switches opening into the sidings and cross-roads of a station from a central signal-box, supplemented afterwards by the admirable arrangements for interlocking, and the simultaneous control of signals as depending on the altered positions of those switches. Then the invention of the electric telegraph enabled instant communication between station and station, and afterwards the establishment of the block system, which, when carried out properly, would seem to have reduced the chances of collision to a *minimum* so far as signaling was concerned.

## Torpedo Experiments.

(From the *London Times*.)

THE torpedo experiments against the *Resistance*, armor-plated ship, moored fore and aft in Fareham Creek, Portsmouth, reached the culminating point this afternoon (November 2d), the attack having suddenly approached, at a bound, from a range of 25 feet to actual contact with the ship. The interest aroused by the experiment was greater than on any previous occasion, as nothing less was expected than that the veteran ironclad would receive its quietus, and be either blown to pieces or sunk. It was also the first time that a real *Whitehead* had been exploded in actual contact with a real ship of war, and it was hoped that much information would result, not only as regarded the destructive effects of the engines fired at close quarters, but with respect to the value of double bottoms and coal bunkers in circumventing the effects of the burst, and the importance of water-tight bulkheads in localizing the inrush of water. The result proved another disappointment for the attack, in spite of the considerable injury that was inflicted. As a matter of fact, the ship was placed under every disadvantage, while everything was done to add to and aggravate the power of the assault. The *Resistance* was placed in chancery, so to speak. She was deprived of her net defenses and moored in shallow water, while a 16-inch torpedo, charged with 93 pounds of gun-cotton, was lashed to a boom and placed longitudinally, fore and aft, in contact with the port side of the hulk amidships. The submersion was about eight feet, which brought the torpedo immediately above the bilge keel. It was not, however, supposed that there would be any overhang or bulge of the ship beyond 18 inches. At 20 minutes past 3, the torpedo was exploded upon a falling tide. The shock was not greater than in previous experiments, and the amount of water thrown up not unusual. So far as sensation was concerned, the effect was tame and disappointing, for the simple reason that something extraordinary was counted upon. The ship was thrown slightly to starboard by the energy of the explosion, after which she slowly listed to port, but not much. It was evident that her bottom had been damaged, and that, notwithstanding the application of a collision mat, water was finding ingress—in fact, the mat was useless, as there was no rush of water to force it into the rents. As an observation of the water-line showed that the ship, after heeling over to a definite angle, remained stable, it was supposed that she had touched bottom and that she would inevitably have sunk had she been moored in deep water, but subsequent investigation proved that she was still afloat and could have been brought into harbor, had such been required. The bilge keel had been shaken off and broken to the extent of 20 feet, while the plating below was very much indented. Above the bilge keel three or four strakes of the skin plating, extending up to the armor belt, had also been forced inward where they crossed the longitudinal frames. They had parted in the middle to the length of 8 feet, while some of the butts had been opened, so that gashes, two and three inches wide, appeared at the junction. There were also a few holes observable in various parts. Internally the skylights had been smashed, and the contents of the bunkers scattered in all directions. The exact amount of the damage done inside will only be accurately known after the ship has been docked. But what is of greatest importance is the fact that the water-tight bulkheads remained intact, and, by confining the water to one compartment, sufficed to keep the *Resistance* afloat and capable of fighting her guns. Indeed, there is no resisting the impression from these experiments that the value of the *Whitehead* has been greatly exaggerated. The torpedo cannot get through the steel protective nets, and when it dashes itself against them and explodes, the consequence is *nil*, at a distance of 25 feet. It also remains to be mentioned that the test to-day was scarcely a practical one, as the fixity of the missile against the side of the ship did not allow for its rebound before bursting. The comparative effect of the rebound of a *Whitehead* striking at a great speed ought to be determined, and also the consequence of the burst upon the boilers and steam pipes of the *Resistance* under a working pressure of steam.

Commenting on the above the *Times* says, editorially: A very important experiment in the modern art of naval

warfare was carried out yesterday in Portsmouth Harbor, by the explosion of a *Whitehead* torpedo in actual contact with the bottom of a ship of war. A full account of the proceedings will be found in another column. The ship submitted to the experiment was the *Resistance*, an obsolete ironclad, which has already been made the subject of a series of experiments, both with artillery and submarine explosives. The interior of the vessel had been prepared so as to represent the modern arrangements of coal defense, for the protection against submarine attack of those portions of a vessel's hull which are not covered by a defensive armor. A 16-inch *Whitehead* torpedo, charged with 93 pounds of gun-cotton, was lashed to a boom and placed longitudinally in contact with the ship's side, immediately above the bilge keel, about 8 feet below the surface of the water. In this position the torpedo was exploded, and, as compared with the anticipations formed of its destructive effects, the result was singularly disappointing. A considerable portion of the external plating of the ship was forced inward and displaced, leaving gaps and gashes through which the water could pass. Internally, the skylights were smashed, and the contents of the bunkers containing the coal defense were scattered in all directions. But the ship was not sunk, as had been expected, and the water-tight bulkheads remained intact, so that if she had been in action, she could have kept afloat and continued to fire her guns, and could have been brought into harbor for repairs. Every advantage was given to the torpedo. The vessel was stationary, and the torpedo was leisurely attached in a position adapted to give it the *maximum* of destructive power. In actual warfare, the torpedo would have to strike the vessel with its point, and a certain amount of rebound would take place before the explosion could occur. It should, however, be noticed that, as our Portsmouth correspondent further points out, we can draw no inference either from the experiment of yesterday, or from those which preceded it, concerning the possible effects of a torpedo explosion on the boilers and steam-pipes of a vessel actually under steam at the moment of attack.

Yesterday's experiment is of great importance, if only as being the first instance in which a real *Whitehead* torpedo has been exploded in actual contact with a real ship of war. It is not, of course, entirely conclusive, for the reasons we have briefly given above; but, taken in connection with the experiments previously made on the *Resistance*, it furnishes a rough measure of the offensive capacities of the torpedo. Those capacities are evidently not so great as has often been supposed. Admiral Mayne stated lately, in the House of Commons, that his recent experience with the Channel Flect had led him to think that the value of torpedoes against ships of war had been very greatly exaggerated. The late Hobart Pasha drew a similar inference from his actual experience in the Russo-Turkish war. The only practical result of the use of torpedoes in that war, was to furnish the Turkish government gratuitously with a secret which many other governments had purchased at a great price. A torpedo launched by a Russian vessel against the Turkish fleet at Batoum, was diverted by a stockade erected by Hobart Pasha for the purpose, and went harmlessly ashore. The Turkish authorities thus came into possession of the secret of its mechanism, and were enabled to make their own terms with the manufacturer. The opinion of Admiral Mayne and the conclusions of Hobart Pasha have now been corroborated by the experiments atPortsmouth. The problem of torpedo attack and defense divides itself into two main branches, according as the vessel attacked is stationary or in motion. A vessel at anchor anticipating attack is now protected by steel wire netting of a peculiar make specially adapted for the purpose. This netting is suspended from booms rigged out from the ship's side so as to form a sort of crinoline, completely enveloping the ship from the level of the water-line to a depth corresponding to the submersion of the vessel. It is very important to determine the *minimum* distance from the ship's side at which the torpedo netting will afford secure protection against torpedo attack, because the weight, and still more, the leverage of the booms, and by consequence, the difficulty of fixing them and maintaining them in position, increase with every increase of their length. To this object, the first series of experiments conducted with the *Resistance* was directed. In the first instance, the nets were boomed out to a distance of 30 feet, and the Whitehead torpedo was fired against them. The ship was entirely uninjured by this attack. The nearest boom was unshipped from its support, but all the others remained intact. The meshes in the immediate neighborhood of the actual explosion were carried away, but the area of positive destruction was so exceedingly limited that a second discharge would have proved just as harmless as the first, unless it happened to pass through the rent in the defenses inflicted by the first. Subsequent explosions were effected at distances of 25 feet, of 20 feet and of 15 feet. At 25 feet, no serious damage was done. At 20 feet, on one occasion, the ship was found to be leaking in consequence of the fracture of one of the valves; and similar effects, though considerably more serious in character, were produced by the explosion at 15 feet. Finally, a torpedo was launched against netting suspended at a distance of 25 feet from the ship. In this case the vessel itself, though severely shaken at the moment of explosion, was not materially nor permanently injured, though the rear boom in the wake of the point aimed at was blown away from its hook,—a result which was held to demonstrate the weakness of the existing hinge arrangement. The net result of this series of experiments seems to be that a stationary ship can be effectively protected against torpedo attack by wire netting properly secured at the extremities of booms of a *maximum* length of 25 feet. For practical purposes, it may possibly be found safe to reduce the length of the booms somewhat further, the line of complete security evidently lying somewhere between 15 feet and 25 feet, and somewhat nearer to the superior than to the inferior limit.

For a vessel in motion, on the other hand, protection by means of wire netting seems to be impracticable. Even if it could be permanently kept in position, the netting would seriously reduce the speed of the ship and impair its handiness in manœuvering. Accordingly, it has hitherto been supposed that a ship in motion would have to trust very much to chance for security against torpedo attack, to the difficulty of taking accurate aim with the torpedo against a moving object—a difficulty practically illustrated by the failure of the *Shah* to hit the *Huascar* with her torpedoes—and to the element of uncertainty which, in spite of all attempts to correct it, still attaches to the path of a torpedo through the water. But it has been very generally assumed that if a torpedo could, at any time, manage to hit a moving ship fairly and squarely, and to explode under these circumstances,

the ship would inevitably be sent to the bottom. If it does nothing else, yesterday's experiment overthrows this assumption. A torpedo has been exploded in actual contact with the unarmored part of the bottom of the *Resistance*, and though the vessel was seriously injured and her plates were started, bulged and rent, she remained afloat; she could still have fired her guns, and was sufficiently seaworthy to have made her way to an adjacent harbor. The crucial result of the experiment is, that the water-tight bulkheads remained intact. We call it a crucial result because naval constructors have mainly relied on a system of subdivision, by means of water-tight bulkheads, for defense against torpedo attack. The theory, of course, is, that so long as the bulkheads remain intact, without rent or leak, the water may be freely admitted into one compartment—or even more, up to a certain definite limit—without causing the ship to sink. Now, this is, so far, mainly a matter of calculation. A naval constructor knows, or ought to know, how many of the water-tight compartments can be filled with water without danger to the ship; but, in default of actual experiment, he cannot determine with certainty the capacity of the bulkheads to resist the effects of concussion. If the torpedo makes a rent in the outer skin of the ship, the water, of course, enters into the compartment laid open by the explosion; but, so long as the bulkheads remain intact, that is a contingency already provided for. Of course the damage is serious, but ships cannot expect to escape unscathed when they go into action. On the other hand, it is not fatal; it is a damage that can be repaired, and, in the meanwhile, it does not paralyze the fighting power of the ship, nor expose her to inevitable capture or destruction. At a single stroke, therefore, the torpedo has lost half its terrors. It is no longer the unseen and insidious enemy which can send a ship to the bottom whenever it can strike the blow. It is formidable, but not irresistible. Its moral terrors will quickly evaporate as soon as its offensive powers are shown to be no more certainly fatal than those of other modern weapons of warfare. At a distance of 25 feet its attacks against a stationary vessel can be completely neutralized. Its explosion in actual contact with the ship leaves her floating and seaworthy, with her offensive powers not materially impaired. If these conclusions, which are provisional and tentative as yet, are corroborated and established by further experiments, a very material change will be effected in the theory and practice of naval warfare.

## Accidents on British Railroads.

*Summary of Accidents and Casualties which have been reported to the Board of Trade as having occurred upon the Railways in the United Kingdom during the Six Months ending 30th June, 1886.*

### I. ACCIDENTS TO TRAINS, ROLLING-STOCK, PERMANENT WAY, &C.

ACCIDENTS to trains, rolling-stock, permanent way, &c. caused the death of 11 persons, and injury to 364, viz.:

| | | | Total for the corresponding period in 1885. | |
|---|---|---|---|---|
| | Killed. | Injured. | Killed. | Injured. |
| Passengers..... | 8 | 324 | 5 | 175 |
| Servants of companies.. | 3 | 40 | 4 | 25 |
| Total..... | 11 | 364 | 9 | 200 |

During the six months there were reported 24 collisions between passenger trains or parts of passenger trains, by which 1 passenger was killed, and 191 passengers and 15 servants were injured; 19 collisions between passenger trains and goods or mineral trains, &c., by which 1 servant was killed, and 36 passengers and 8 servants were injured; 7 collisions between goods trains or parts of goods trains, by which 2 servants were killed, and 12 were injured; 30 cases of passenger trains or parts of passenger trains leaving the rails, by which 6 passengers were killed, and 40 passengers and 4 servants were injured; 2 cases of trains traveling in the wrong direction through points, by which 1 servant was injured; 7 cases of trains running into stations or sidings at too high a speed, by which 34 passengers were injured; 158 failures of axles, by which 2 passengers were injured; and 2 failures of couplings, by which 1 passenger was killed and 21 were injured.

The following cases were also reported, but they involved no personal injury: 1 case of a train coming in contact with a projection from a wagon; 1 case in which part of a goods train left the rails; 54 cases of trains running over cattle* or other obstructions on the line; 19 cases of trains running through gates at level crossings; 2 failures of engine machinery; 411 failures of tires; 123 broken rails; 14 floodings of the permanent way; 12 slips in cuttings or embankments; 4 fires in trains; 3 fires at stations or involving injury to bridges or viaducts; and 1 other accident.

Of the 411 tires which failed, 9 were engine tires, 1 was a tender tire, 11 were carriage tires, 7 were van tires, and 383 were wagon tires; of the wagons, 288 belonged to owners other than the railway companies; 349 tires were made of iron, 60 of steel, and in 2 cases the material was not stated; 12 of the tires were fastened to their wheels by Gibson's patent method, and 12 by Mansell's, none of which left their wheels when they failed; 3 by Beattie's patent method, one of which left its wheel when it failed; 381 by bolts or rivets, 4 of which left their wheels when they failed; and 3 by other methods, one of which left its wheel when it failed; 28 tires broke at rivet-holes, 6 at the weld, 64 in the solid, and 313 split longitudinally, or bulged.

Of the 158 axles which failed, 95 were engine axles, viz., 84 crank or driving, and 11 leading or trailing; 11 were tender axles. 1 was a carriage axle, 46 were wagon axles, and 5 were salt-van axles. 21 wagons, including the salt-vans, belonged to owners other than the railway companies. Of the 84 crank or driving axles, 59 were made of iron and 25 of steel. The average mileage of 56 crank or driving axles made of iron was 229,882 miles, and of 25 crank or driving axles, made of steel, 219,198 miles.

Of the 123 rails which broke, 59 were double-headed, 63 were single-headed, and 1 was of the bridge pattern; of the double-headed rails, 38 had been turned; 21 rails were made of iron, and 102 of steel.

### II. ACCIDENTS TO PASSENGERS FROM CAUSES OTHER THAN ACCIDENTS TO TRAINS, ROLLING-STOCK, PERMANENT WAY, &C., INCLUDING ACCIDENTS FROM THEIR OWN WANT OF CAUTION OR MISCONDUCT; ACCIDENTS TO PERSONS PASSING OVER LEVEL-CROSSINGS; TRESPASSERS; AND OTHERS.

Of the 239 persons killed and 404 injured in this division, 43 of the killed and 303 of the injured were passengers. Of the latter, 9 were killed and 19 injured by falling between carriages and platforms, viz., 7 killed and 10

* During the six months 8 horses, 1 pony, 23 beasts and cows, 45 sheep, and 4 donkeys were run over and killed.

injured when getting into, and 2 killed and 9 injured when alighting from trains; 3 were killed and 210 were injured by falling on to platforms, ballast, &c.. viz., 31 injured when getting into, and 3 killed and 179 injured when alighting from trains; 14 were killed and 10 injured whilst passing over the line at stations; 27 were injured by the closing of carriage doors; 5 were killed and 6 injured by falling out of carriages during the traveling of trains; and 12 were killed and 31 injured from other causes. 39 persons were killed and 17 injured whilst passing over railways at level-crossings, viz., 23 killed and 14 injured at public level-crossings, 9 killed and 2 injured at occupation crossings, and 7 killed and 1 injured at foot-crossings. 97 persons were killed and 42 injured when trespassing on the railways; 37 persons committed suicide on railways; and of other persons not specifically classed, but mostly private people having business on the companies' premises, 23 were killed and 42 injured.

III. ACCIDENTS TO SERVANTS IN THE EMPLOY OF RAILWAY COMPANIES OR CONTRACTORS, CAUSED BY THE TRAVELING OF TRAINS OR THE MOVEMENT OF VEHICLES USED EXCLUSIVELY UPON RAILWAYS.

During the six months there were 199 servants of companies or contractors reported as having been killed and 918 injured, in addition to those included in Division I. Of these 15 were killed and 152 injured whilst coupling or uncoupling vehicles; 2 were killed and 12 injured by coming in contact, whilst riding on vehicles during shunting, with other vehicles, &c., standing on adjacent lines; 12 were injured whilst passing over or standing upon buffers during shunting; 9 were killed and 80 injured in getting on or off, or by falling off engines, wagons, &c., during shunting; 4 were killed and 72 injured whilst breaking, spragging, or chocking wheels; 3 were killed and 16 injured whilst attending to ground points, marshaling trains, &c.; 3 were killed and 83 injured whilst moving vehicles by capstans, turntables, props, &c., during shunting, and 22 were killed and 152 injured by various other accidents during shunting operations; 5 were killed and 21 injured by falling off engines, &c., during the traveling of trains; 4 were killed and 9 injured by coming in contact with over-bridges or erections on the sides of the line during the traveling of trains; 11 were killed and 61 injured whilst getting on or off engines, vans, &c., during the traveling of trains; 1 was killed and 52 were injured whilst attending to, or by the failure of machinery, &c., of engines in steam; 42 were killed and 53 injured whilst working on the permanent way, sidings, &c.; 2 were killed and 1 was injured whilst attending to level-crossing gates; 34 were killed and 45 injured whilst walking, crossing or standing on the line on duty; 8 were killed and 20 injured by being caught between vehicles; 6 were killed and 11 injured by falling or being caught between trains and platforms, walls, &c.; 27 were killed and 9 injured whilst walking, &c., on the line on the way home or to work; and 1 was killed and 57 were injured from various other causes.

Altogether, the number of persons killed and injured on railways in the United Kingdom in the course of public traffic, during the six months ending 30th of June, 1886, as reported to the Board of Trade, was as follows:

| | | | Total for the corresponding period in 1885. | |
|---|---|---|---|---|
| Passengers: | Killed. | Injured. | Killed. | Injured. |
| From accidents to trains, rolling-stock, permanent way, &c .... | 8 | 324 | 5 | 175 |
| By accidents from other causes. | 43 | 303 | 35 | 295 |
| Servants of companies or contractors: | | | | |
| From accidents to trains, rolling-stock, permanent way, &c .... | 3 | 40 | 4 | 25 |
| By accidents from other causes. | 199 | 918 | 208 | 944 |
| Persons passing over railways at level-crossings..... | 39 | 17 | 30 | 7 |
| Trespassers (including suicides). | 134 | 42 | 133 | 50 |
| Other persons not coming in above classification..... | 23 | 42 | 20 | 36 |
| Total..... .... | 449 | 1,686 | 435 | 1,532 |

*Note.*—In addition to the above, the railway companies have reported to the Board of Trade, in pursuance of the 6th Section of the Regulation of Railways Act, 1871, the following accidents which occurred upon their premises, but in which the movement of vehicles used exclusively upon railways was not concerned, namely: 55 passengers injured whilst ascending or descending steps at stations; 18 injured by being struck by barrows, falling over packages, &c., on station platforms; 12 injured by falling off platforms; and 19 injured from other causes. Of servants of companies or contractors, 3 killed and 464 injured whilst loading, unloading, or sheeting wagons; 141 injured whilst moving or carrying goods in warehouses, &c.; 2 killed and 79 injured whilst working at cranes or capstans; 1 killed and 77 injured by the falling of wagon-doors, lamps, bales of goods, &c.; 156 injured by falling off, or when getting on or off, stationary engines or vehicles; 7 killed and 85 injured by falling off platforms, ladders, scaffolds, &c.; 109 injured by stumbling whilst walking on the line or platforms; 114 injured whilst attending to stationary engines in sheds; 23 injured by being trampled on or kicked by horses; 2 killed and 262 injured whilst working on the line or in sidings; and 97 injured from various other causes. Of other persons, most of whom were transacting business on the companies' premises, 4 were killed, and 62 injured—making a total in this class of accidents of 19 persons killed and 1,773 injured.

Thus, the total number of personal accidents reported to the Board of Trade by the several railway companies during the six months amounts to 468 persons killed and 3,459 injured.

## On the Remarkable Effects of Adding Saccharine Matter to Mortars.

BY SAMUEL CROMPTON.

(From *The Engineer.*)

A letter from Mr. Thomson Hankey "On a New Use of Sugar"—*Times*, October 13—has given rise to wide discussion and inquiry. At a time when the price of sugar is so low, and, as I shall show, when the use of a very small quantity of it, or of treacle, adds largely to the strength of mortar, and makes Portland cement itself set with great rapidity, it seems to me that I may do a service to engineers by laying before them the scientific grounds on which I was led to experiment on the subject, and the remarkable results which have been obtained.

The practical importance of this addition of saccharine matter to mortar I will state briefly, to begin with, and will give a few illustrations:

I mixed in a small jar some Portland cement and brown sugar, adding water, and stirring. I took out a little of the cement for an experiment, and when I tried an hour after to take out more, I found that the remainder had already set.

My neighbor, Mr. Rowland, weighed carefully Portland cement and sand into four small jars. To two he added different sugars, to the third treacle, but to the fourth no saccharine matter. On the following day the cement had set—we do not know how much earlier, for it was not examined—in all the jars with saccharine matter. Mr. Holden, Jr., the foreman of a builder, examined all of them on the Monday following the Friday on which they had been mixed. On pressing the cement to which the treacle had been added, he said: "I might press the bottom of the jar out before I can make impression on this." He then put his finger into the jar in which there was no saccharine matter, and stirred up the cement which had not set at all, and which did not set till a day or two after. It may be objected that it might not be an advantage that it should set so quickly. This objection will be answered by-and-by as I proceed, by showing that it is highly probable that the strength of Portland cement will be greatly increased by this addition of saccharine matter.

Mr. Thomson Hankey had experiments made, first by his own brickmaker and secondly by a housebuilder. Both reported that the addition of sugar made a common lime equal to Portland cement,

The bearing of these facts will be plain to every engineer, but I cannot forbear mentioning here a startling incident. The Ecclesiastical Commissioners built for the late Bishop Fraser, of Manchester, on his coming into the diocese, a lodge like that at Lambeth, with a lofty archway set in Portland cement. A clerk of the works appointed by the architect of the commissioners superintended it. After a due time the scaffolding was removed. One day—perhaps that day—the bishop walked through and had just got beyond danger, when the whole of the archway fell. If he had been under it he would have been killed, and his grand career as a bishop would have been cut short at the outset. Your readers, as I proceed with my statement, will judge for themselves whether the addition of a few shillings-worth of treacle would not have made all secure, and have saved the expense of doing this work over again.

hav to exp. in how it is that sugar, or rather saccharine matter of any kind, produces this remarkable effect on lime. Here I ought to mention that I am a retired physician, and that the idea of putting the matter to the proof arose in the following manner: In medicine we have two kinds of lime water, one the common lime water that can be got by mixing lime and water. It is to be particularly noted that, add as much lime as you like, it is impossible to get water to dissolve more than half a grain of lime in one ounce, or about two small tablespoonfuls of water. But by adding two parts of white sugar to one part of lime, we obtain a solution containing about 14½ times more lime in the same quantity of water. Here it is to be observed—and it is a most important point—that there are hot limes, such as Buxton lime, which, if the sugar be incautiously mixed with them, will *burn* the sugar, make it a deep brown color, and convert it into other chemical forms, and possibly, and I think probably, will destroy its value in mortar. The way to use sugar with such limes is to dissolve it first in the water. I dwell particularly upon this because a gentleman referred to me by Mr. Thomson Hankey, in writing to thank me for the information I had given him, casually observed that his cement had turned nearly black by the addition of the sugar. Probably many other experimenters with sugar and hot limes have had the same result, and are in the belief that all is right. Our strong medical saccharated lime water looks like water.

Ten or fifteen years ago I had been experimenting with lime and sugar, but not in reference to mortar, and I spoke about that time to my friend, the late E. W. Binney, F. R. S., about this property of sugar. He said that it was very curious, and that it was new to him; and he told me this anecdote, that in his grandfather's time an Italian architect came down to Worksop to erect a building for a nobleman, and insisted on being supplied with malt to make his mortar with. The malt was supplied and used. Many years afterwards this building had to be taken down; but, said Binney, "they could not pull it down, do what they would, and they had to use gunpowder." I said it would be the saccharine matter in the malt that produced this result. He agreed with me.

A few months ago I was at Peterborough, and went to see the progress of the restoration of the cathedral, where I made the acquaintance of Mr. Irvine, Mr. Pearson's clerk of the works. Mr. Irvine was for more than a quarter of a century with Sir Gilbert Scott, and possesses a greater knowledge of architecture, and antiquity bearing on English architecture, than any one I ever met with. One day I said to him that I had been to Fotheringay. He replied that he had seen every other church than that in the neighborhood of Peterborough. I asked him to go with me on his Saturday's half-holiday, as my visit to the church had been a hurried one, and I wished to make some further inquiries. Besides, I was glad to have the companionship of one who was so thorough a master of the subject. The chancel of this fine church, built before the nave, and so late as 1410, has entirely perished; and it had been so badly built that even in the time of Queen Elizabeth it had fallen in and was then in ruins. The chancel and tower exist, but the tower is unsafe, and if the church be not soon restored this grand historical monument may suffer or be destroyed. As Mr. Irvine and I walked to the railway station, I asked him whether he was aware of the chemical fact that the addition of sugar to water makes it take up about sixteen times more lime than water by itself does—I might have said a little more than fourteen times. He replied that he did not know this fact, and that he had never heard of it, and that he did not believe that it had been so used in mortars. I then told him what Mr. Binney had told me regarding the building erected by the Italian architect near Worksop. He said that he had been clerk of the works in the restoration of several cathedrals, in the books of which he had met with old entries of payments "For beer for the masons," and that he had found one entry where it was written, "For beer to mix with the mortar." said that that would be for the saccharine matter in it; and I added that a few years ago I had seen in a newspaper that the vintage in Spain had been so abundant that the people had not casks enough, and were using the wine to mix with their mortar. It flashed across my mind that this traditional use of saccharine matter was probably the explanation of the exceptional hardness of the old Roman mortar, and had been handed down from generation to generation, and had at length been forgotten, in England

at any rate. A few days afterwards I was pondering as I walked along the street in Peterborough on this matter, when suddenly I said to myself, "Why not try the experiment?" I went into a grocer's shop and bought a pound of exceedingly finely powdered loaf sugar and some beeswax—of the wax I will speak some other time. I took the sugar to the hut in the cathedral yard, where I found the foreman of the contractor and Mr. Irvine. Laughing, I said, "I have come to teach you to suck eggs." After explaining to the intelligent foreman my views, he and Mr. Irvine kindly agreed to try the experiment. Some powdered lias lime and some of the sugar were being mixed together in an iron basin. Water was added, and Mr. Irvine began to stir them with a trowel. No sooner had he done so than he exclaimed, "Look, look! It is beginning to set already." I said, "Is not that usual?" He replied, "No; something very uncommon." The mortar was poured out on the end of a beam, where it set. Some more was then made, much thinner, and a little sand added to it. With this, which was about the consistency of cream, two large fragments of the broken stone tracery of an old window were joined, and so were two bricks, two pieces of glass, and two slates. It would be about five o'clock in the evening. As I was going to leave Peterborough about noon on the following day, I called at the cathedral about ten in the morning to see the results. Mr. Irvine said it was too early to judge. He felt at the stone tracery very tenderly. Holding the upper fragment, he then tilted the tracery sideways, and as the stones held together, he then took hold of the upper fragment with both hands and lifted the whole stone without the lower fragment falling off. In like manner, in lifting both bricks the lower brick did not fall off. The slate and the glass seemed also set. So that the experiments seemed to confirm remarkably the view I had formed, on theoretical and chemical grounds chiefly, that saccharine matter added to mortar would be of great value and that an important discovery had been made. I wrote to my brother-in-law, Mr. Guildford Molesworth, engineer-in-chief to the state railways in India, and author of "The Engineer's Pocket Book," telling him what we had done. From him I received a letter dated Simla, August 28th, 1886, giving me the following interesting particulars: "With regard to your addition of sugar to mortar, it is a practice that has been in use in the Madras presidency from time immemorial." The following is an extract from the Roorha (?) "Treatise on Civil Engineering," Vol. I., page 150, third edition: "It is common in this country to mix a small quantity of the coarsest sugar —'goor,' or 'jaghery,' as it is termed in India—with the water used for working up mortar. Where fat limes alone can be procured their bad qualities may in some degree be corrected by it, as its influence is very great in the first solidification of mortar. Captain Smith attributes the fact that mortars made of shell-lime have stood the action of the weather for centuries, to this mixture of jaghery in their composition. He made experiments on bricks joined together by mortar consisting of 1 part of common shell lime to 1½ of sand. One pound of jaghery was mixed with each gallon of water with which the mortar was mixed. The bricks were left for thirteen hours, and after that time the average breaking weight of the joints in twenty trials was 6½ lbs. per square inch. In twenty-one specimens joined with the same mortar, but without jaghery, the breaking weight was 4½ lbs. per square inch."

Mr. Molesworth then adds: "The use of sugar or jaghery was known to me when I was in Ceylon twenty years ago. The masons who came over from Madras used to make most beautiful plaster work, almost like enameled tiles, of shell lime mixed with jaghery. The surface took a fine polish, and was as hard as marble; but it required a good deal of patient manipulation, well suited to the national character."

This intelligence from India supplies proof of the most positive kind of the enormous strengthening power of sugar when mixed with mortar. It may be argued that some of our limes and cements are of themselves good enough without it. It is for engineers to judge whether they might not be made much better by it, or whether the facts I have brought forward do not show plainly that there should be an inquiry instituted by scientific men to investigate the actual *numerical* value of sugar, and the various conditions under which it acts, whether for better or worse. For the worse it cannot act, except such an insane use of it be made by adding too much, as to expect sugar to be itself mortar. The jaghery sugar used in India is sold in the London market at, I think, less than a penny a lb., and is used for feeding cattle. Treacle seems to me to be a most promising form of saccharine matter. I would shirk beet-root sugar. There is a rough unrefined treacle which is very cheap, and I should suppose would be excellent. A halfpenny-worth of treacle and water added to a hod of mortar would, I conjecture, increase its strength by one-third, if not by one-half. But I must leave the matter in the hands of scientific engineers. I think it is very probable that this use of sugar with lime is of extreme antiquity, and that a knowledge of it passed from India to Egypt and Rome; and that these nations used malt for its saccharine matter as a substitute for sugar. I have shown that the mediæval builders used beer in building our cathedrals, and beer is still used with plaster-of-paris. These I take to be the remnants of ancient tradition. It is said that in the cold winter when Bess of Hardwicke died, her masons had to "melt the beer which they mixed with their mortar." They would have acted more wisely if they had used infusion of malt only, for most of the sugar must have been converted into alcohol, and lost for the purposes of mortar making. Antiquarians may be able, from old documents, to throw light upon this subject; but I strongly suspect that the old Roman mortar had saccharine matter added to it; and I am of opinion that, in all engineering works requiring great strength, it would be wrong not to take advantage of facts confirmed by the experience of ages.

CRANLEY, SURREY, November 30th, 1886.

## The Technical Education of the Shipwright and Shipowner.

AT the present time this subject should have an especial interest to Americans, from the fact that there is a general public opinion that we ought (speaking in a Hibernian way) to make an effort to regain some of the ground which we have lost on the sea, and it is the evident purpose of the people, and of the government, to make a very material increase in the navy of the country. The following abstract, taken from the London *Times*, of a lecture by Sir E. J. Reed, M. P., will be read with interest and perhaps profit by people to whom it does not

seem to occur that any great amount of special training is needed to build ships or to create a navy.

"Sir E. J. Reed said he would not be guilty of any exaggeration in saying that the technical education of the shipwright and the value of technical education to the shipowner in any broad sense of the words were matters not only of this century but almost of this generation. Nor was this so surprising when it was remembered that whereas the material of which ships were built, the manner in which their parts were combined, and the means by which they were propelled had remained unchanged from the beginning of human experience down to almost our own day, the ship had recently been transformed in every one of these important particulars. The steamship of the present day gave rise to many technical necessities. She was built mainly of steel both in hull and in machinery, and trustworthy steel could only be produced by a large and free application of technical knowledge. The plates of which her hull was constructed were the result of several refined and careful operations. Only by the most thoughtful, patient, and persistent technical study, both theoretical and practical, had the steel plate been produced. Every steel manufactory had become a technical school of chemistry, metallurgy, and mechanics, and the more the shipwright knew about his steel plates the better would it be for him. In his own department, however, he would find abundant opportunity and necessity for technical skill in dealing with his plates. It had, for instance, recently been shown that steel plates of perfect quality were liable to undergo great deterioration in the shipyard or the boiler shop if subjected to pressure and change of form at improper temperatures. It was one thing to procure good steel ship plates and to work them properly; it was another to combine them in the most efficient manner into a structure. The plates had to be bound together with rivets, and the placing of these rivets was a matter of very great importance to the shipowner, for their improper disposition had ruined many a good ship, and it needed much technical skill so to dispose them under all circumstances as to weaken the hull as little as possible. The design and construction of the marine steam engine also made heavy demands upon technical skill with a view of economizing not so much steam and fuel as weight. The naval architecture of the past—that which flourished in the construction of wood ships down even to our own day—although in many respects admirable and beautiful, was, if judged by its results, a poor affair. He had on more than one occasion bore testimony to the great skill of those who produced our splendid wooden line-of-battle ships. But when the steam engine and the screw propeller came in either the material or the technical skill failed us. It may be said that wooden, steam line-of-battle ships did good service in their day, although their day was but a very brief one. But the royal harbors bore abundant witness in the days of his youth to the weakness of the screw steamship built of wood. He well remembered, when a shipwright's apprentice in Sheerness dockyard, taking note of many a steam line-of-battle ship lying at her moorings in the Medway, with her back bent, and, some cases broken, on account of her steam machinery; not on account of the force exerted by her machinery when under steam and at sea, for many of them had never been to sea at all, but on account of the mere weight of her screw propeller and stern shafting overcoming her longitudinal strength. We trusted to the wooden steamship a little too long, and were too reluctant to see her yield to the thrust of the oncoming hull of iron and of steel. The technical knowledge requisite to guide the shipwright in building his iron or steel plates into a structure such as a modern fast steel liner, a tenth of a mile long, capable of being driven across stormy oceans at a speed of a third of a knot per minute, or of 33 ft. per second, without breaking or even straining unduly, had been brought into being gradually and for the purpose. The adaptation of the strength of a long and large steamship to the very great and very variable strains that she would be subject to at sea was indeed a problem upon which much earnest work had yet to be done as the development of shipbuilding advanced. But enough had been done to lay upon the shipwright heavy obligations as to technical study. This was not a matter in which success could be secured by mere brute effort or heedless expenditure. A ship was a construction in which its very strength might become its weakness. It was quite easy—it had often been done by incompetent persons—to lavish material in such places and in such a manner as to weaken the structure in one place by overburdening it at another. Many persons failed sufficiently to realize the nature of the forces which a big ship at sea had to encounter, and failed to fully understand that the movements of such a body, weighing many thousands of tons, transcended all other human experiences of motion and ranked in magnitude with the great catastrophes and cataclysms of nature. Where else on earth save in the case of ships did one find man imparting swift motion to vast masses of matter, wielding and guiding at his will bodies as big as small mountains and propelled by forces that vied with those of earthquakes. In these days the shipbuilder was nothing if not technically trained and instructed, and this necessity for technical knowledge and training descended into the minute details of a shipwright's work. His view of the necessity for technical knowledge went the full length of desiring to see technical instruction extended not merely to the masters and professors of the craft, but to all who were engaged or to be engaged in the production or working of ships. (Hear, hear!) There were people who would be quite ready to promote technical education, in order to serve the purpose in view, in two ways. First, they would like to see the shipbuilders and their sons and their principal officers thoroughly well trained for their work, and secondly, they would like to see provided enough of technical education for the working classes and apprentices engaged in shipbuilding to enable clever young men here and there to rise into higher positions and make their way in their trade or profession. But these objects, though laudable in themselves, fell very far short of what he considered the necessities of the case. He wanted to see educated not only those who had risen or might rise above the hard-working class, but that class itself. (Hear, hear!) This was a competitive age. In such an age we must conceive continually new and improved things, or else we fell astern in the race. In other countries technical education was freely imparted to the people, and they consequently drew their improvements and their mechanical progress from the largest area of cultivated talent. The establishment of the Admiralty Technical Schools of Naval Architecture had been very beneficial in this country, and great good would be obtained if its work was extended more widely and if there was a general diffusion of technical training throughout

the great seaports of the country. The time had come when elementary education was imparted to all children; was it too much to hope that before long all those young men who were destined to become shipwrights or marine engineers would be supplied with opportunities for learning how to apply that elementary education to trade uses? The young men themselves, and society at large, would be the better in many ways for such instruction. The education of young men in matters concerning their daily avocations, and the laws of nature with which they came most into contact, gave to their lives an active interest, for want of which so many sank into idleness and evil."

## THE WESTINGHOUSE ELECTRIC LIGHTING SYSTEM.

(From *The Electrician and Electrical Engineer.*)

MUCH interest has been excited in electrical circles by the editorial announcement made in our last issue respecting the success of experiments recently made with the system of electrical distribution by induction, which is about to be introduced by the Westinghouse Electric Company, of Pittsburgh. This interest has been heightened by statements which have appeared in the public press purporting to set forth some of the results which have been attained Having been permitted to examine the apparatus in actual operation, we purpose at an early day to present our readers with a detailed description of the plant; meanwhile a brief statement of the facts, which may be relied upon as accurate, so far as it goes, will doubtless be of interest. The test which we witnessed was made in Pittsburgh. The dynamo was located in the factory of the Westinghouse Electric Company on Duquesne Way and Garrison Alley, Pittsburgh, and the lamps were situated at a distance of three miles from the generator in a suburb of the city, best known as Lawrenceville. The conductor used was No. 4 B. W. G. copper wire, six miles in length out and back, and having a resistance of 6 ohms. The generator is of the alternate class, and was originally designed by William Stanley, Jr., some of the details of the present model having been worked out by Messrs. Westinghouse, Shallenberger, Byllesby, Schmid and others. It is a remarkably well designed, efficient and handsome machine. The body of the armature is cylindrical, 23 inches in diameter and 12 inches face, and is formed of discs of iron magnetically separated from each other, the conducting wire being wound in flat coils upon its face. The field magnets, 16 in number, are arranged in a circle, with their poles facing inward toward the armature and in close proximity thereto. The dynamo is driven at the rate of 1,080 revolutions per minute. thus giving 17,260 alternations of the current per minute or 288 per second. The weight of the entire machine is about 7,000 pounds, and the total weight of copper wire on the armature and field magnet about 800 pounds. The potential at the terminals of the dynamo when running is maintained at about 1,100 volts. An independent exciter is employed for the field, consisting of a small Stanley direct current dynamo of 150 volts and 10 amperes, driven at 1,800 revolutions per minute. The alternate dynamo and exciter are both belted to the shaft of an 18 by 16 Westinghouse automatic engine, rated at 200 h. p., and making 276 revolutions. The potential at the terminals of the main conductors, 3 miles from the dynamo, is 1,000 volts., showing a drop of only 10 per cent. The inductoriums, or "converters," as they are technically called, are placed at the point of consumption, and have their primary wires attached to the main conductors and their secondary wires to the leads which extend through the premises to be lighted and to which the lamps are attached in the usual manner. In the present installation each converter contains 112 pounds of iron and 43 pounds of copper, and is capable of supplying 50 16-candle incandescent lamps at a potential of 100 volts. In one long continued test 850 lamps and in another 1,000 lamps were lighted to their full candle-power on this circuit, and the high commercial efficiency of the system as a whole may be estimated by the result which was obtained of a little in excess of 8 lamps per indicated horse-power.

It will be seen from these data that not more than 1 pound of copper per mile is required for each lamp in this system. It is easy to estimate the immense saving in the cost of installation of an electric light plant which is capable of being realized by the use of this invention. The system of the Westinghouse Company as now perfected is based upon the fundamental patents of Messrs. Gaulard and Gibbs, whose apparatus has for some time been in successful use, though only to a limited extent, in England. Many modifications and improvements have been added to the original system by Mr. Westinghouse himself and by Messrs. Stanley, Shallenberger and other electricians of the company. The remarkable results which we have above chronicled are in fact the outcome of more than a year of elaborate and costly experimentation by a number of the ablest electricians in the United States.

### Irrigation in Queensland.

CLIMATIC influences in Queensland, which is a British colony in the northeastern part of Australia, it is said in *Engineering*, appear to run in cycles, long periods of extreme wet succeeding to seasons of unwonted dryness, so that a good system of irrigation would be a great advantage, and it has lately been occupying the attention of the colonists.

The means of irrigation already adopted are various. Windmills of the modern American type are often used for watering stock, and for other farm as well as gardening purposes. They are generally erected over wells, as water appears to be got in almost any parts if the sinking be of sufficient depth. Californian and chain pumps are used by the Chinese, who are largely employed in raising market garden produce in the neighborhood of large towns. The pulsometer pump is also used to a great extent with the colonial gardeners, its simplicity of action, no doubt, appealing strongly to those unskilled in mechanics in a country where engineering establishments are rare, and metal workers of all kinds get very high wages. But in situations where large volumes of water have to be raised, the centrifugal pump naturally commands the situation, and upon some of the large sugar plantations of the north, very important installations of centrifugal steam pumping-engines have been erected. In the Burdekin district, twelve such irrigating plants are now at work.

# New Inventions.

December 14, 1886.

During the month of November, 1886, the Patent Office of the United States passed to issue letters patent numbered, in series, from 351,730 to 353,653, both inclusive; of which 377 bear date as of the second; 400 as of the ninth; 398 as of the sixteenth; 374 as of the twenty-third, and 375 as of the thirtieth of said month.

The whole number issued was 1,923; one, under date of November 23d, having been withdrawn.

One hundred and forty-one patents, or 7⅓ *per cent.* of the entire issue, are for devices designed for application to "railway purposes."

Twenty-one for use on horse and cable roads, respectively; two are specifically for use on "elevated" roads; and one hundred and nineteen are for railroads operated by steam locomotives generally.

The devices designed for improvement of current practice on horse-railroads are: Brake, 1; brake-rod handle, 1; car coupler, 1; car draw-hook, 1; car heater, 1; car starters, 4.=9.

For cable-roads: Concrete mold, for forming cable subway, 1; cable, 1; cable grips, 6; curve pulley, 1; and cable-railway plants, 2.=11.

For railroads operated by steam locomotives generally:

| | | | |
|---|---|---|---|
| Air compressor attachment for locomotive | 1 | Electric lighting of trains | 2 |
| Axle | 2 | Electric locomotive | 1 |
| Axle-box dust-guard | 1 | Frog and switch | 2 |
| Axle box | 5 | Frog | 2 |
| Axle bearing | 1 | Gate for street crossings | 3 |
| Brake-gear, adjustable for regulating travel of beam | 1 | Gate fastener | 1 |
| Brake, pneumatic train brakes | 4 | Guard for street crossings | 1 |
| Brake pawl | 1 | Journal | 1 |
| Brake operated by fluid pressure | 1 | Locomotive | 3 |
| Bag-catcher, mail | 1 | Locomotive boiler | 3 |
| CARS— | | Locomotive furnace | 1 |
| Dumping car | 1 | Oiler | 1 |
| Express car | 1 | Piston, balanced | 1 |
| Stock car | 1=3 | Rail, for inside of curve | 1 |
| Car couplings | 31 | Rail braces, manufacture of | 1 |
| Car-coupling link | 1 | Seal lock | 1 |
| Car door, freight | 1 | Snow-plow | 1 |
| Car heater | 1 | SIGNALS— | |
| Car-heating and lighting, combined | 1 | Train signals | 1 |
| Car lamp | 1 | Road signals | 6 |
| Car seat | 2 | Spark arresters | 3 |
| Car spring | 1 | Spike | 1 |
| Car truck | 4 | Switch | 3 |
| Car-wheel chill | 1 | Switch, without frog | 1 |
| Car-wheels and axle-handling apparatus | 1 | Tie, of metal | 3 |
| Coupler for brake-hose | 1 | Turn-table | 1 |
| Exhaust quieter | 1 | Traction increaser | 1 |
| Exhaust relief | 1 | Valve | 1 |
| | | Valve-gear | 1 |
| | | Valve-seat dresser | 1 |
| | | Velocipede | 1 |

Among the 31 "couplers" (and the same is true of any lot of like number heretofore patented) there are several affording evidence of great, if not entire, ignorance, on the part of the inventors respectively, of the conditions under which a car-coupling is necessarily operated. Some of the November lot in question are of particularly fantastic form.

One of the group, however (No. 351,964), shows very simple, and presumably effective, devices for reception, detention and release of link, and for holding the link horizontally in position to engage opposing draw-gear. It would couple *automatically* with any link-carrying draw-gear, as well as with one of its own pattern; provided the link, coming to be engaged with No. 351,964, be presented so that it may hit the orifice of the "throat" of the draw-head of said coupler. It would receive, and secure, any *hand*-guided link without any handling of a *pin* on the part of the person making the coupling.

Of devices other than couplers, there are several noticeably ridiculous. As for instance: One shows a railroad rail having an undulating surface, with six or seven considerable "waves" in a length of 30 feet. In another, instead of a car-wheel of the conventional form, there is a circular plate, rotating on a fixed axle, bearing on its edge small wheels, set "roller-skate" fashion; which small wheels are to "take their places in quick succession" upon the rail. This contrivance would, presumably, prove "a rattler," indeed

In improvements in locomotive fire-boxes and boilers, we find, under No. 352,215, devices for securing, in a chamber adjacent to the flues of the boiler, a thorough combustion of the gases produced in the fire-box; and in No. 352,217 a fire-box of two compartments, one devoted to the production of gas (from coal used for fuel); and the other—adjacent to the rear flue sheet of the boiler—used as a combustion chamber, into which the aforesaid gas, mixed with air, charged into it by means of a flue provided for that purpose, is introduced at will.

We note also a turn-table, designed to be operated by the weight of any burden (ordinarily a locomotive) placed upon it; such weight being made effective through certain springs and a spiral inclined plane.

In car-seats, No. 352,055 has several good features.

In our review of the November patents we have, perhaps, overlooked some device the "introduction" of which will "revolutionize" railway practice in the line in which such device is intended to serve; but, with our present view of the matter, we have to say, further, only that the month's illustration of the work of our inventors of railway appliances indicates an unflagging industry; and, on the whole, a promising advance in appreciation of the subjects handled. J. M. G.

## System of Electric Distribution,*

*Specification forming part of Letters Patent, No. 351,589, dated October 26th, 1886, to Lucien Gaulard and John D. Gibbs, of the County of Middlesex, England, Assignors to George Westinghouse, Jr., of Pittsburgh, Pa.*

Application filed March 6th, 1886. Serial No. 194,229. (No model.)

*To all whom it may concern:*

BE IT KNOWN, That we, Lucien Gaulard, a citizen of the republic of France, and John Dixon Gibbs, a subject of the Queen of Great Britain, both of the county of Middlesex, England, have jointly invented certain new and useful Improvements in Methods and Apparatus for the Distribution and Conversion of Electric Energy, of which the following is a specification:

Our invention relates to the distribution of electrical energy for industrial purposes, and it consists in an improved art or method, and an organization of apparatus whereby the same is carried into effect, by means of which we are enabled to transmit from a central or supply station through a main conductor a primary electric current of comparatively small quantity but of high potential, and at a point or points more or less distant where the said electric energy is to be utilized, to transfer the energy residing in such primary current of high potential, into one or more secondary currents of lower potential but of greater quantity. To this end the invention comprises certain combinations of apparatus having an organization and mode of operation particularly adapted to effect such transference of electric energy.

By means of our improved method and apparatus we are enabled to convey a useful quantity of electric energy to a much greater distance than has heretofore been practicable, while the cost of the necessary plant for electric lighting and other analogous purposes, especially that of the main electrical conductors, is very materially diminished.

The accompanying drawings represent an organization of apparatus which we have found to be well adapted for carrying out our invention.

Fig. 1 is a theoretical plan showing the general principle of the apparatus; Fig. 2 is a transverse vertical section of one form of converter, and Fig. 3 is a diagram showing one plan of arranging the apparatus when the transference of energy is to be effected at more than one point.

In the drawing, D represents a dynamo-electric generator of suitable construction, organized for the production in the main line of alternating currents, that is to say, successive electric currents or pulsations, alternately of positive and negative polarity and of equal potential and duration. We have found by experiment that the

* We are indebted to *The Electrician and Electrical Engineer* for the engravings accompanying the specification.

dynamo-electric machine of Alteneck, described in United States Letters Patent No. 234,353, of November 9th, 1880, is well adapted for our purpose; but we do not desire to confine ourselves to any particular constructiono f generators for setting up alternating currents in the line, as there are many forms of these known and used which will serve sufficiently well.

In order to operate a dynamo-electric machine for the production of alternate currents, it is necessary to provide some means for maintaining its magnetic field. This may be accomplished by a separate current derived from an independent dynamo machine, technically termed the "exciter." Such independent exciter is shown in the drawing at E. It may be an ordinary direct-current dynamo machine, of any suitable construction. The current of the exciter E is conducted from its terminals *p*, *p*, by means of wires 1 and 2, to and through the field-magnet helices of the main dynamo or generator D.

coil has heretofore usually been employed to transfer electric energy from currents of low potential and great quantity into currents of high potential and small quantity, the function of the secondary generator or converter as applied in our invention is precisely the reverse of this, namely, to transfer electric energy from currents of high potential to currents of low potential and increased quantity. We have constructed converters for effecting this result in a variety of forms, all of which involve the same principle. In order that this principle may be better understood, we will describe the construction and mode of operation of a simple form of the converter which we have shown at C in figure 1. Two iron cores *b*, $b^1$, are preferably built up from a large number of small soft iron wires, insulated from each other and mechanically secured together in a solid bundle. It is usually preferable to unite the ends of the cores so that they will become magnetically continuous. In figure 3 for example, we have shown

*Fig. 1.*

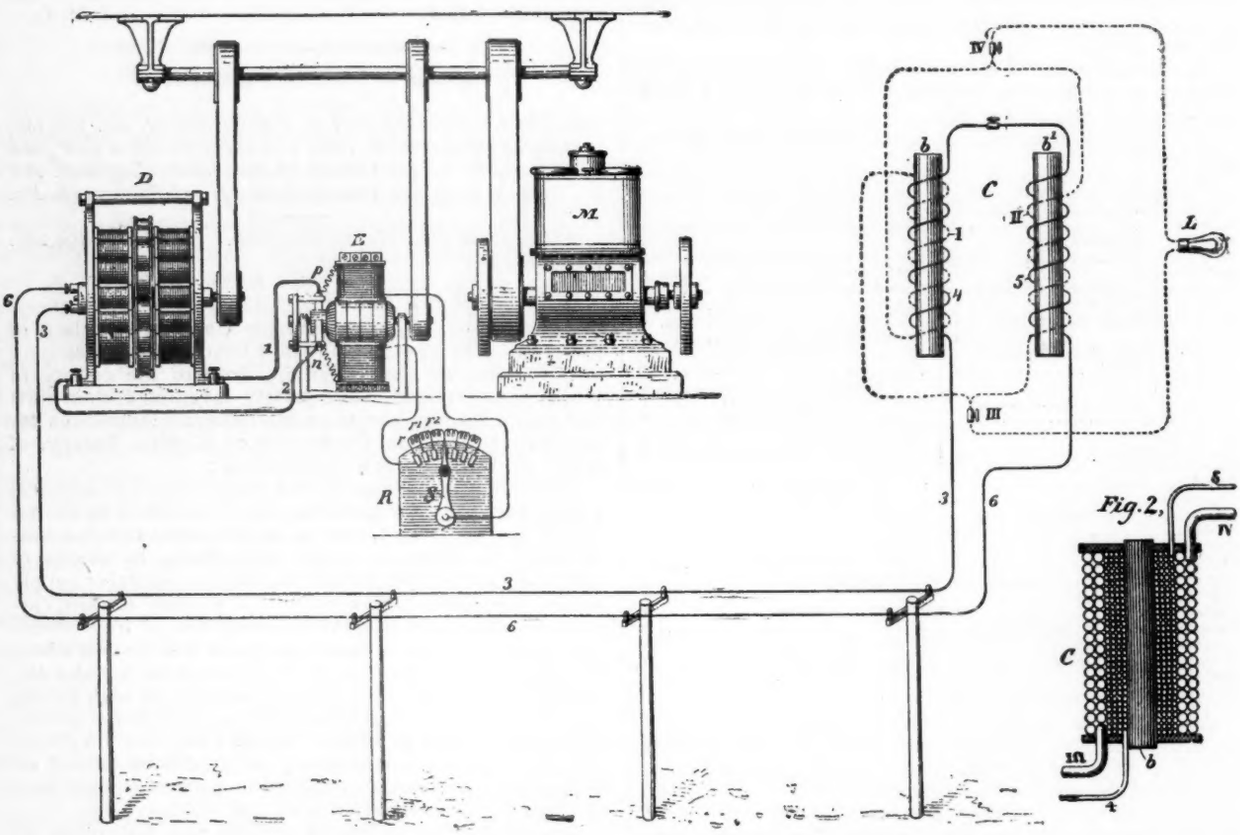



*Fig. 2.*




In order to vary when required the electromotive force of the generator D, it is convenient to effect a corresponding variation in the strength of the current in the field produced by the exciter E. This may be done in the case of a shunt-wound exciter, by an adjustable resistance inserted in the field of the exciter. We have shown this plan in the drawings. R is a rheostat composed of a series of graduated resistance coils *r*, $r^1$, $r^2$, etc. A movable contact-arm or other equivalent device is provided, by means of which the current for maintaining the field produced by the exciter E may conveniently be regulated. The same result may be reached in other well-known ways. The power for operating the main dynamo D, as well as the exciter E, is furnished by a suitable steam engine or other convenient motor M.

At a point where the electric current is to be utilized for any suitable purpose, as for instance, in one or more incandescent electric lamps, we place one or more secondary generators of converters, as shown at C in figure 1. The general principle of our secondary generator is analagous to that of the well-known inductorium or induction coil, with this exception, that while the induction

the cores in the form of a rectangle; but the core or cores may be straight cylinders, or closed figures of oval, annular, horseshoe, or other shape, this being merely a matter of convenience in construction or economy in operation, but involving no change of principle. Around the cores *b*, $b^1$, the primary electric conductors 4 and 5 are disposed helically in the manner shown in the drawing, which, however, is intended to represent the arrangement of these conductors in a symbolical or typical manner only, the actual construction being preferably similar to that shown in figure 2, hereinafter to be described. By inspection of the drawing it will be seen that one conductor, 4, is coiled upon the left-hand portion of the core, and the other similar conductor, 5, upon the right-hand portion, and the two conductors 4 and 5 are then connected at their adjacent ends, that a current may traverse them in series and thus develop magnetism in the iron cores *b*, $b^1$, so as to establish a magnetic field surrounding or enveloping said cores and adjacent thereto. The secondary conductors I. and II. are disposed in precisely the same manner around the cores *b*, $b^1$, and within the same magnetic field. In the particular arrangement

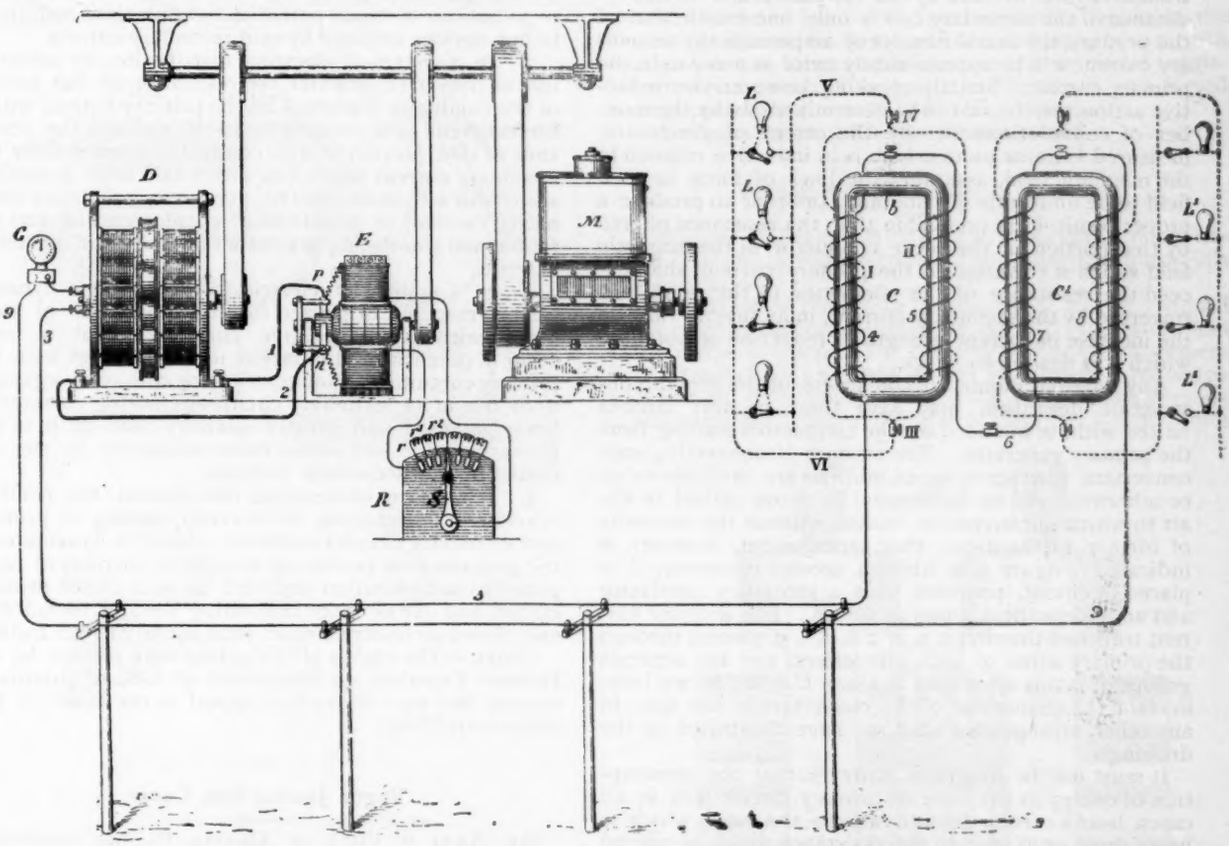
shown in figures 1 and 3 of the drawing, each convolution of the secondary conductor is interposed between two adjacent convolutions of the primary conductor, so that the number of convolutions as well as their mean distance from the axis of the core is the same. Experience indicates that the more nearly the last mentioned relation is preserved, the higher will be the efficiency of the apparatus. The relative disposition of the primary and secondary helices may otherwise be greatly varied without material change in the result; for example, one may be superposed upon the other as in figure 2, or the two may be placed upon different parts of the same core or cores, according to circumstances. It is to be observed that the secondary conductors shown in figure 1 of the drawings are not united in series like the primary conductors, but their ends are joined together as shown at III. and IV., in parallel or multiple arc, and from the last named junction points of the secondary, the conductors

mary currents ordinarily are, by including proper translating devices in said secondary circuit.

The most important and characteristic feature of our invention is that which renders it possible to make use of alternating and equal positive and negative currents of moderate quantity but of very high potential, in the primary or main line circuit, and to convert these into secondary or induced currents of much greater quantity but of corresponding lower potential at the place of consumption, which secondary currents are employed to do the required work. This is a result, the attainment of which is of the utmost importance in the art of electrical distribution, as it renders practicable the employment of insulated main conductors, of comparatively small size and moderate cost, for the transmission of large amounts of energy to great distances.

We will now explain the means by which this increase of quantity and reduction of potential in the secondary

*Fig. 3.*




V. and VI. are led to an electric lamp or other translating device L by which the circuit is completed.

We will now describe the mode of operation of the apparatus. When the dynamo-electric generator D is set in operation, a rapid succession of alternating positive and negative currents or pulsations of equal potential and duration, technically termed an alternating current, is set up in the main or primary conductor, the path of which may be traced in figure 1 as follows: From one terminal of the generator D by the line conductor 3 to the primary conductor 4, 5 of the secondary generator C, thence returning by the line conductor 6 to the opposite terminal of the generator. The alternate current proceeding from the primary generator D, by its inductive action in the secondary generator C, creates a magnetic field of alternate polarity, and this alternation of the magnetism of the field, in accordance with a well-known law, generates by inductive reaction an alternate current in the closed circuit of a secondary conductor situated within it. The secondary current may be utilized for electric lighting or other purposes in the same manner that primary circuit is effected. Let it be assumed that we have an electric lamp, as L in figure 1, so constructed as to work at maximum efficiency when rendered luminous by an electric current of 1 ampere. Let it also be assumed that, for economical or other reasons, it is desired to employ an alternate current of 0.5 ampere only in the primary circuit. The necessary increase in the quantity of the secondary current will, in such case, be effected by the apparatus when arranged precisely as shown in the figure, for as the primary conductor of the converter C is connected in series, while the secondary conductor (with an equal number of convolutions situated in the same magnetic field) is arranged with one-half its convolutions in multiple arc with the other half, the result will be precisely the same as if the actual number of convolutions of the secondary conductor were only half as many as those of the primary. The total resistance of the secondary conductor when thus connected, is obviously only one-fourth as great as that of the primary, the secondary being double the cross-section, and virtually only one-half the length of the primary.

When an electric current of alternating polarity is caused to pass through the primary conductor of the converter C—figure 1—it creates by electro-magnetic induction a magnetic field, the intensity of which, within the ordinary limits of working, is proportional to the current (expressed in amperes) passing through the conductor. Each alternation so produced in the magnetism of the field tends to set up a definite electromotive force in each separate convolution of any conductor traversing the field. In the primary conductor this electromotive force opposes itself temporarily to the primary or magnetizing current, but as it is of inferior and rapidly decreasing potential, it acts merely to delay, and not to prevent, the magnetization of the field. An approximately equal electromotive force is at the same time set up in each convolution of the secondary conductor, but, as the latter (in the present example) makes only half the number of convolutions within the field, the total electromotive force of the secondary current will be only one-half that of the primary current. Inasmuch, however, as the value of any current is expressed by the quotient of the electromotive force divided by the resistance, and as the resistance of the secondary coil is only one-fourth that of the primary, the actual number of amperes in the secondary current will be approximately twice as many as in the primary current. Strictly speaking, however, the inductive action may be said to be determined, not by the number of convolutions but by the extent of conductor, measured in linear units, which is in inductive relation to the magnetic field, assuming the lines of force in such field to be uniformly distributed. In order to produce a proper result, it is preferable that the resistance offered by that portion of the linear conductor in the magnetic field which is traversed by the primary current, shall exceed the resistance of the conductor in the same field traversed by the secondary current, in an inverse ratio to the increase in current strength or reduction of potential which it is desired to effect.

Any required number of converters, of the general construction described, may have their primary circuits united with, or included in, the conductors leading from the primary generator. The manner of connecting such converters, whether in series, multiple arc, multiple series, or otherwise, will be understood by those skilled in the art to which our invention relates, without the necessity of further explanation. One arrangement, however, is indicated in figure 3, in which a second converter, C′, is placed in circuit, provided with a secondary conductor and an independent group of lamps. The primary current traverses the circuit 3, 4, 5, 6, 7, 8, 9, passing through the primary wires of both converters, and the separate groups of lamps are shown at L and L′. We do not herein claim the connection of the converters in the line, in any other arrangement than we have illustrated in the drawings.

It must not be forgotten, however, that the consumption of energy in the main or primary circuit will, in all cases, bear a certain definite ratio to the work which is being done, or at least to the resistance which is offered at any given time in the secondary circuits of the converters, whether one or many. The attendant at the generator, by means of an electro-dynamometer or other suitable current indicator, G—figure 3—can readily detect any change in the strength of the current due to variations in the consumption, and, by moving the arm S, can correspondingly raise or lower the electromotive force of the generator D, so as to bring the current back to its normal strength.

The converter C may be constructed in various ways. We have attained excellent results by constructing it in the manner more particularly shown and described in prior United States patents, Nos. 297,924 of April 29th, 1884, and 316,354 of April 21st, 1885. Another form which gives excellent results in practice, is shown in figure 2, in which *b* is a core formed of a bundle of iron wires, around which the primary wire 4 is coiled in a helix of the ordinary form. The helix of the secondary wire III., IV., is superposed upon that of the primary, in the manner shown. The sectional area of the secondary wire is here shown as four times that of the primary, while the number of convolutions is only one-fourth as great. We nevertheless do not desire to confine ourselves to any particular construction of the converter, as this is quite immaterial so long as the essential principles which we have hereinbefore set forth are not departed from.

We claim as our invention:

1. The hereinbefore-described art or method of electrical distribution and conversion, which consists in establishing in a closed electric circuit, a current of alternate and equal positive and negative potential, producing by the influence of such current an inductive field of alternate polarity, and thereby inducing in translating devices situated in an independent closed circuit traversing such field, a similar alternating secondary current of greater quantity and less potential than the originating or producing current.

2. In a system of electrical distribution, an inductorium or converter, in which the length of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the length within the same field of the conductor traversed by the secondary current, in combination with a dynamo-electric generator producing alternating electric currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

3. In a system of electrical distribution, an inductorium or converter, in which the resistance of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the resistance of that portion of the conductor traversed by the secondary current which lies within said field, in combination with a dynamo-electric generator producing alternating currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

4. In a system of electrical distribution, a dynamo-electric machine, organized for the production of alternate positive and negative currents, equal to each other in potential and duration, in combination with the primary curcuit of an inductorium or converter organized to induce in its secondary circuit alternating currents of lower potential and greater quantity than those of the primary circuit, and one or more translating devices actuated by said secondary currents.

5. In a system of electrical distribution, the combination of an inductorium or converter, having its primary and secondary circuits constantly closed, a dynamo-electric generator for producing alternating currents of equal potential and duration included in said closed primary circuit, and one or more translating devices included in said closed secondary circuit, substantially as set forth.

[NOTE.—The claims of this patent were refused by the Primary Examiner on the ground of lack of patentable novelty, but were allowed on appeal to the Board of Examiners-in-Chief.]

## Vogt's Journal-Box Cover.

MR. AXEL S. VOGT, of Altoona, Pa., has patented a cover for railroad journal-boxes. His invention is described as follows in his specification:

Figure 1 is a central sectional elevation through the axle-box and its lid; Fig. 2, a side elevation of the same; Fig. 3, a front view of that part of the hinge which is cast with the axle-box; Fig. 4, a perspective view of the same on the section *x x* of Fig. 3. Fig. 5 is a back view of the hinge put together; Figs. 6 and 7, side and front views of the compressing-arm. Fig. 8 is a diagram illustrating the action of the device when in use.

A is the axle-box, having the rim, *a a*, around its open end made flat and level.

B is the hinge lug or section, secured to or cast with the box. The form and construction of this hinge-lug is fully shown in Figs. 3, 4, and 5. It is perforated longitudinally for the reception of the hinge-pin, as shown in Fig. 5, and at *b*, Fig. 4.

In the front of the hinge-lug $B^2$ is an open slot, $b^2$, and at the top of the slot, and near the top of the lug, is a recess, *b′* (see Figs. 3 and 4), forming a bearing for the compressing-arm E, Figs. 6 and 7.

$b^3$ is a projection on the back of lug B.

C is the lid which closes the opening in the box A. If

desired, it may have a rim of soft metal cast into a recess in its fitting-face which rests upon the rim *a* of the box.

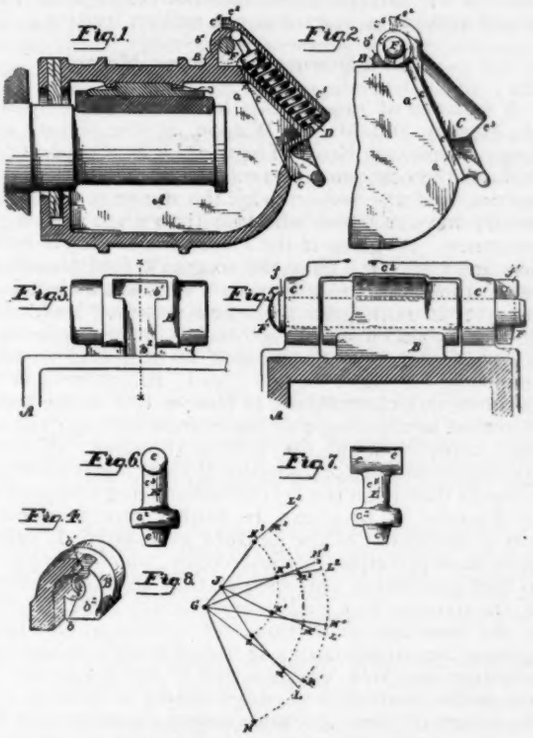
*c' c'*, Fig. 5, are lugs perforated for the reception of the hinge-pin, and adapted to register with the lug B.

$c^2$ is a curved hood which projects over the top of the hinge, covering the recess *b'*, and terminating in a shoulder, $c^5$, adapted to rest against the shoulder $b^2$ when the lid is open.

$c^3$ is a hollow box or pocket cast in the lid C and open at the top.

D is a spiral spring contained in the pocket $c^3$. The axial line of the pocket must be such as will, when the lid is closed, form a very obtuse angle, such as J K L, Fig. 8, with the compressing-arm E, hereinafter described, which angle will have its apex pointing toward the box.

E is the compressing-arm, having at its top circular projecting arms *e e*, which are adapted to rest in the horizontal recess *b'*, and at its bottom a plug *e'*, adapted to enter the spring D, and a collar, $e^2$, to rest against the end of the spring. This collar $e^2$ should be large enough to nearly fill the opening $c^3$, though capable of moving freely in it. The shaft $e^3$, of the arm E, is of a size which permits it to move freely in the slot $b^2$.




VOGT'S JOURNAL-BOX COVER.

F is the hinge-pin; *f*, an elastic washer.

*f'* is a key to retain the pin F in place.

To secure the lid to its hinge, the compressing-arm E is first placed in its bearings *b'* and the spring D is placed in its box $c^3$. The end *e'* of the arm E is then inserted in the end of the spring and the lid C then pressed upward into its proper position, when the perforations of the lugs B and *c'* will be in line and the pin F may then be inserted. The upper or bearing surface of the recess *b'* should be made to project forward sufficiently to prevent the end *e*, of the compressing-arm E, from slipping out; but, as an additional protection, the projecting hood $c^2$, is provided, which will prevent the arm E from slipping out of place, and also serves as a shield to the hinge mechanism.

The operation of the device will be readily understood, and is illustrated in the diagram, Fig. 8.

When the lid C is closed, as shown in Figs. 1 and 2, the face of the lid is in the line G H, Fig. 8, and the axial line of the arm E is represented by the line J K, while the line K L indicates the axial line or line of pressure of the spring D, the points G and J being, respectively, the fixed centers of the hinge and of the bearings upon which the ram E turns. As will be seen, the spring D being under compression, its power is exerted in this position to keep the lid C tightly pressed down upon its seat, and the lid can only be opened by further compressing the spring.

G H' and G $H^2$ are two intermediate positions of the lid-face while being opened, the corresponding axial lines of the arm E being shown by the lines J K' and J $K^2$, and of the spring D by the lines K' L' and $K^2$ $L^2$, while G $H^3$ shows the face of the fully opened lid, the arm E being then indicated by J $K^3$ and the spring by $K^3$ $L^3$. As indicated by this diagram, the angle J K L becomes more obtuse as the lid is forced open until, after becoming a straight line, the apex of the angle reappears in the reverse direction and the force of the spring is then exerted to open the lid C, the shoulders $b^2$ and $c^5$ serving as stops to prevent the lid from being too widely opened. The pressure of the spring D is, of course, sustained by the hinge-pin F, which is thus tightly clamped between the lug D and the lugs *c' c'*. The elastic washer *f*, by drawing the key *f'* tightly against the lug *c'*, also aids to prevent the pin being shaken loose by the motion of the car.

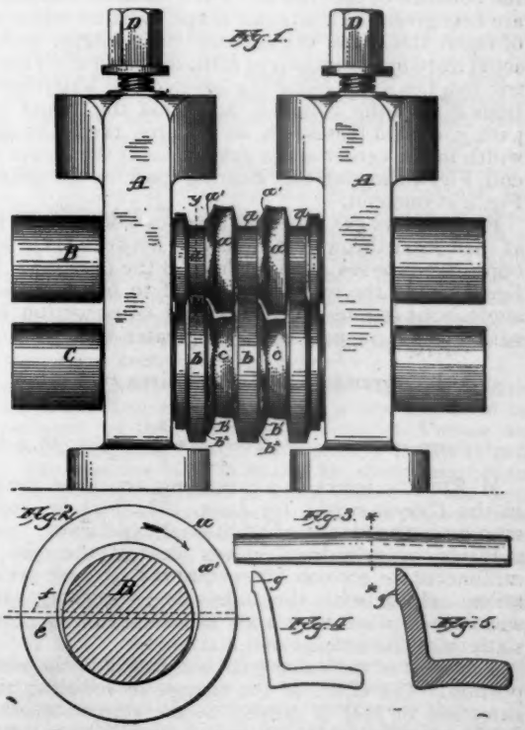
The essential feature of the invention consists of the arrangement of the spring and the compressing-arm with respect to the hinge and lid-face, so that an elastic toggle-joint will be formed to keep the lid closed, and closed and opened substantially in the way indicated.

The patent is dated November 16th, 1886.

## Rolling-Mill for Rolling Fish-Plates.

William B. Parkes, of Bay View, Wis., has patented improvements in rolling-mills. The following is from his specification:

My invention relates to rolling-mills, and is designed for rolling angle-irons—such as railway fish-plates; and it consists in the peculiar construction and arrangement of a train of rolls whereby, at one revolution a reduction is had at both ends of the irons, to leave the greatest thickness at the center, or that portion on which comes




ROLLING-MILL FOR ROLLING FISH-PLATES.

the most strain, as will be hereinafter described with reference to the accompanying drawings.

Referring by letter to the drawings, A A represent suitable standards having journaled therein, after the usual manner, a pair of rolls, B C, the top one, B, being held down in operative relation to the lower one by means

of set-screws D. The top roll, B, is provided with one or a series of tongues, *a*, and the lower one, C, with collars *b*. The tongues *a* of the top roll are in line vertically with the grooves *c*, between the collars *b* of the lower roll, and these collars are likewise arranged with relation to recesses *d*, between said parts *a* of the top roll.

The irons are rolled between the tongues *a* of the top roll and the grooves *c* of the lower one, the faces of these opposing parts being of such contour as to give said irons the requisite outline after being rolled.

The tongues *a* of the top roll are eccentric to the latter's line of axis, as best illustrated by Fig. 2, the relative centers of both this roll and its tongues being respectively shown by the full line *e* and dotted line *f* in said figure.

The collars *b* on the lower roll all have their center on the line of axis of said roll, and the axial line of both rolls determines the centers from which are struck the circumferences of the intervals between the respective parts *a b* of said rolls.

The irons to be treated by my improved rolls are first formed in the usual manner, and are of equal thickness throughout their entire length. These irons, after being suitably heated, are severally fed to the rolls B C, when the eccentric tongues *a* of the top one are at their greatest throw, and the distance between them and the grooves *c* on the lower one the least. The end of the iron first engaged is reduced by the pressure exerted and the surplus metal forced toward the other end. The pressure gradually diminishes as the throw of the eccentric tongues lessens until a half-revolution is accomplished, when, as the throw of said eccentric begins to increase, this pressure is correspondingly increased until the greatest throw is again attained and the iron passed out from the rolls.

The operation just described leaves each iron thickest in its center and gradually tapered therefrom toward each end, as shown by Fig. 3, while the pressure faces of the rolls give said iron the desired contour, this resu t being accomplished at one revolution of the rolls.

In the manufacture of fish-plates, I provide the eccentric tongues *a* of the roll B with a bevel, *a'*, that is also eccentric and opposes a bevel, *b'*, and a shoulder, $b^2$, on the collars *b* of the roll C. The blanks for the fish-plates are first given their angular shape by other rolls, but are of equal thickness throughout their length, and, when acted upon by my improved rolls, the bevel *a'* on the eccentric tongues *a*, opposing the beveled and shouldered portions $b'$ $b^2$ of the collars *b*, act upon the upper bearing part, *g*, of said plates, so as to give them the greatest width in the center and a gradual taper therefrom to each end, Fig. 5 showing this bearing part at its center and Fig. 4 at one end.

Fig. 1 shows the eccentric tongues *a* on the roll B when at their least throw, and the space between them and the opposing grooves *c* on the roll B the greatest. In this figure I show the rolls constructed to operate upon two angle-irons at one time; but this construction may be varied so as to accommodate a greater number.

## Improvements in Locomotives in France.

BY — RICOUR.

*(Compte-rendu de la Société des Ingénieurs Civils, 1885, p. 684.)*

M. RICOUR refers to a preceding article on the subject in the *Compte-rendu*, for June, 1884, and he now communicates the results of additional experience.

Piston or cylindrical valves wear at the rate of one millimeter for 200,000 kilometers run ($\frac{1}{25}$ inch for 125,000 miles), whilst, with the slide-valve, the same extent of wear takes place after 2,060 miles are run, or about one-sixtieth of the mileage-run.

The wear of the valve-gear is reduced in the same proportion. The effect of the change in reducing the consumption of fuel is proved by the returns made at the Saintes station, which show that, in the year 1882, when all the engines worked with slide-valves, the coal consumed, per 1,000 tons conveyed one mile, was 266 pounds, against 234 pounds in the year 1884, when 30 out of 40 locomotives had been fitted with cylindrical valves—showing an economy of 12 per cent. in fuel.

The brick arch or partition, commonly erected in the fire-boxes of locomotives in England, has been introduced on the State railways of France. The bricks of which the partition is formed, are supported on water tubes, rising from the lower part of the tube-plate to the crown-plate, so disposed that the partition takes the form of the letter V, and tends, by its form, to direct the flame toward the sides of the fire-box. The author has made experiments on the resistance of the atmosphere to railway trains, by means of balances placed to the right and to the left of the cab, or shelter, on the foot-plate, having disks of 1 decimeter (about 4 inches) square, and a needle, showing the resistance, on a spring. The resistance varies as the square of the speed. At a speed of 44 miles per hour the resistance is equal to 10 pounds per square foot. The resisting surface of a locomotive with its tender, in the direction of motion, is about 135 square feet, and the total resistance at the above rate would amount to ($135 \times 10 =$) 1,350 pounds. This resistance could be considerably reduced by the adoption of inclined surfaces, which have already been applied to some engines. M. Ricour estimates that an increase of 13 per cent. of useful work would be effected by their adoption; and he estimates that, if all the stock of the State railways were modified as he has indicated, the cost of traction would be reduced £160 per engine per year; and the total reduction for all the 7,000 locomotives now in France, would amount to upward of one million sterling.

## The Efficiency of Electric Motors.

A NUMBER of experiments have been made by Mr. W. M. Morday and Mr. C. Watson, at the factory of the Anglo-American Brush Electric Light Corporation, to find out the best principles on which to construct electric motors, and the reason why the dynamo, as a motor, should have a lower efficiency than when working as a generator. As given in the *Philosophical Magazine*, these principles are: (1) That the magnetic field should be a very strong, and the armature a very weak electro-magnet. (2) In both generators and motors, "lead," distortion, or displacement of the brushes or the magnetic field is wrong, and is to be avoided by attention to the (1) condition. If there be any "lead" in dynamos, it is in the direction of rotation; in motors it is in the opposite direction, as the course of the current through the armature is reversed, but the field is the same. (3) In both generators and motors, absence of sparking at the brushes depends mainly on the (1) condition being complied with. (4) Reversal of rotation. In neither generators nor motors is movement of the brushes necessary. It appeared from these principles of construction, which are applicable to both generators and motors, that the lower efficiency of the dynamo as a motor must be due either to friction at the bearings, air friction, and friction of the brushes against the commutator; to loss of energy in heating the armature and field magnets, and to self-induction; or to loss by the production of eddy currents in the iron. From the nature of these probable causes, consideration shows that the last is the true one; for in a dynamo the rotation of the armature causes eddy currents to be generated in the iron core in the same direction as the conductor proper with which the core is surrounded. Of course, as the armature is always more or less subdivided or laminated in a direction at right angles to the lines of force, any circulation of currents round the core is avoided; but local currents or "eddies" are set up, and taken as a whole, these eddy currents on the outside of the core are in the same direction as the current flowing in the copper conductor. In an electric motor, however, the eddy currents and the currents in the copper conductor are in opposite directions, as although the electromotive force set up in the conductor is in the same direction in a motor as in a dynamo, the current in the former is forced through the armature in a direction contrary to the electromotive force. It will be seen that while in a dynamo the two sets of currents, those in the iron and those in the conductor, tend to oppose and to reduce one another, in a motor they act in such a manner as to mutually assist one another. Thus, with the strength of field, the current in the conductor and the speed the same in both cases, the eddy currents in the iron core of the armature will be greater than in a generator, and the loss from heat more. —*Engineering*.

# Notes and News.

**Thirty-six Inch Car-Wheels.**—The Illinois Central Railroad will in future use 36 inch wheels under its cars and tenders.

**Foot-guards** in frogs and switches, of a pattern which will prevent men from catching their feet, will be required of all Massachusetts railroads by law after January 11th, 1887.

**Cable Road in New York.**—The Third Avenue Railroad Company has opened a new cable line in New York City. It is on 125th street, running from the East to the North Rivers.

**Proposals** have been received by the United States Engineer in charge for the construction of jetties at the mouth of the St. John's River in Florida, but the contract has not yet been awarded.

**Messrs. Blackmer & Post,** sewer and culvert pipe manufacturers, have purchased 12 acres of ground having a frontage of 2,000 ft., on the St. Louis, Oak Hill & Carondelet Railway, upon which to build a new factory.

**Electric Brake.**—A train is being fitted up on the Chicago, Burlington & Quincy Railroad, with the Park electric brake. This is to be tested by the committee on automatic brakes appointed by the Master Car-Builders' Association.

**General Joint Car Inspector.**—The roads centering in Cincinnati have decided to appoint a general joint car inspector, who shall decide all matters in dispute between the inspectors of the different roads as to repairs and liability under the interchange rules.

**Consolidation Locomotive.**—The first locomotives of this class built in Canada—though not the first in use on Canadian roads—have been turned out of the Canadian Pacific shops at Montreal. Four of these engines have been built, having 19 × 22 inch cylinders and 51-inch driving wheels.

**Hudson River Tunnel.**—There is some prospect of a resumption of work on the tunnel under the Hudson River between New York and Jersey City. Steam pumps are now clearing the old workings of water. As soon as this is done an inspection will be made to ascertain the condition of the sections already built.

**The Fowler Steel Car-Wheel Company,** of Chicago, are now building on their seven-acre tract, at the north-east corner of Ninety-fifth street and Stony Island avenue, suitable buildings for the manufacture of the Fowler patent solid steel wheels. It is expected the works will be in operation early next spring.

**Torpedo Boats.**—It is reported that at Elbing—Schicpau's Yard—in Germany, at the present time, torpedo boats are being constructed for Austria, Italy, Russia, Turkey, China and Japan, and that through the improvements in both boats and engines those already tried have attained a speed of twenty-four knots an hour.

**The New York, Danbury & Boston Railroad.**—The contract for grading this line has been let to Heman Clark & Co. The road is to run from Danbury, Conn., to a connection with the Suburban Rapid Transit road, north of the Harlem River, and is intended to give the New York & New England an independent line to New York.

**City Engineer Artingstall,** of Chicago, has prepared plans for a viaduct over the railroad tracks at Western avenue and Kinzie street in that city. The bridge is to be of iron, with stone piers and suitable approaches, and the estimated cost is $193,000, of which the City will pay one-third, the railroad companies being required to pay two-thirds.

**Hæmoglobinometer.**—Ernst Fleischl Von Marxow, of Vienna, has taken out a patent in this country for a hæmoglobinometer. His invention, he says, "consists in a method of ascertaining the relative or quantitative proportion of hæmoglolin in the blood." It is, perhaps, well to mention this fact, as otherwise his invention might be mistaken for a new kind of apple-parer, clothes-wringer or car coupling.

**The Chrome Steel Works,** of Brooklyn, N. Y., have concluded to substitute gas for coal in their heating furnaces. It will be necessary to tear out their old furnaces, and put in regenerators in their stead. The new plant will be complete in every respect, even to apparatus, for the manufacture of the necessary gas, which will be made on the premises. This improvement will increase the productive capacity of the works twofold.

**The Knowles Steam Pump Works,** of New York, have taken a contract to supply the water works of Cleveland, O., with compound condensing duplex pumping engines, to pump 23,000,000 gallons a day against a head of 230 feet, with a boiler pressure not exceeding 70 lbs. The engines are to have high pressure cylinders 37 in., and low pressure 70 in. diameter with 4 ft. stroke; the pump plungers are to be 37 in. diameter. The contract price is $79,000.

**United States Engineer Corps.**—The following promotions are reported: Captain James F. Gregory, to be Major, vice Gillespie, promoted. First Lieutenant Willard Young, to be Captain, vice Gregory, promoted. Additional: Second Lieutenant Charles S. Riche, to be Second Lieutenant, vice Sanford, promoted. Captain H. M. Adams, and Second Lieutenants W. M. Black and H. M. Chittenden have been ordered to report at New York, Jan. 10., to be examined for promotion.

**Ship Building on the Lakes.**—Statistics collected by the Cleveland *Plain Dealer* show that thirty-one new boats will be added to the lake fleet next spring, having an average carrying capacity of a little over 2,000 tons each. All except two of them will be large steamers, and they represent a combined carrying capacity of 65,750 gross tons, built at a cost of over $4,000.000. Eleven of the finest of these boats are now under way in Cleveland, and in them Cleveland capitalists will invest $1,500,000.

**Westinghouse Building.**—Ground has been purchased at the intersection of Penn Ave. and Ninth street, Pittsburgh, for the erection of an edifice to be called the "Westinghouse Building." The structure will cost $200,000 and is to be completed by July 1, 1887. It will be eight stories high and will contain the general offices of the Westinghouse Air Brake Co.; the Westinghouse Machine Co.; the Westinghouse Electric Light Co.; the Union Switch & Signal Co.; the Safety Appliance Co., and the Philadelphia Gas Co.

**Port Henry, Essex Co., N. Y.**—The Bay State Furnaces, which have been for about 5 years unused, have recently been purchased by Messrs. Witherbees, Sherman & Co., who own large iron-ore mines in town, besides a broad-gauge railroad from here to Mineville, where their mines are situated. About 50 men are putting the works in shape, and the production of pig-iron will be resumed as soon as possible. The furnaces are situated on the track of the D. & H. C. Co.'s R. R. They were built about 40 years ago by a Boston company.

**Arsenals and Shipyards for China.**—The late director-general of the John Cockerill Company, Baron Sadoine, is proceeding to China, as is said in some quarters by invitation from one of the most influential and powerful persons in the country, to consult about the establishment of very extensive arsenals and shipbuilding yards. This may or may not be. He will, however, find that the French have anticipated him in these two matters; but at any rate, he goes in the interest of Belgian industry, and the masters of works expect great results from his mission.

**System of Conveying Natural Gas.**—The interference case of W. D. Hartupee against George Westinghouse, Jr., and John Nicholson Jr., in the matter of priority of invention of the double-pipe system of conveying natural gas to consumers has been decided by the Commissioner of Patents and Chief Examiner in favor of Hartupee. It is said that a great deal of money is involved, as a number of companies have been paying royalty to Westinghouse for the use of his system. The decision is that of an examiner in the Patent Office and is not final.

**Petroleum Engine.**—A *Times* (London) telegram calls the attention of the British Government to a new petroleum engine invented by Herr Siegfried Marcus, of Vienna, and which he is supplying to the German navy for its torpedo boats. The machine is set in motion by electro-magnetism. It has far more power than a steam engine of the same size, is less liable to derangement, and is not subject to explosions. Moreover, the fuel which feeds it takes up much less space than coal. All the experiments made with this engine have been satisfactory.

**A Remarkable Accident** occurred on the Pittsburgh, Cincinnati & St. Louis road, in Pittsburgh, on the morning of November 18th. As a train was approaching the city, a landslide, starting over 100 ft. above the track, rolled down the steep hillside and struck the rear cars of the train, wrecking two sleeping-cars and injuring nearly everyone in them. The road at this point runs at the foot of the hill and near the river, but it has been built over 30 years and was considered perfectly safe. Heavy rain had softened and loosened the earth near the top of the hill, however, and a slide started, with little or no warning.

**The Croton Aqueduct.**—The contractors on the new Croton Aqueduct for New York City, during the year ending December 1st, completed 14.84 miles of the work. This

makes 20 37 miles now completed, leaving 9.41 miles still to be built. Of the 78,361 feet reported as finished last year, Brown, Howard & Co. built 34,308 feet; O'Brien & Clark, 25,740 feet; Heman Clark, 15,272 feet; and John Brunton & Co., 3,041 feet. The Aqueduct Commission has appointed Messrs. George S. Greene, J. J. R. Croes and James B. Francis a commission to report on the practicability of the proposed dam and storage reservoir at Quaker Bridge.

**The Engineers' Club of St. Louis**, at its December meeting, listened to and discussed an elaborate paper on the "Economic Co-efficient of the Shunt Dynamo," by Prof. F. E. Nipher. The paper gave a mathematical discussion of the theory of the efficiency of this class of machines, and showed the conditions under which a maximum was reached. The life and resistance of incandescent lamps was also discussed. The club appointed a committee of five to consider the subject of a closer connection of existing engineering societies, with a view to forming a general or federal organization.

**Consolidated Petroleum.**—The German correspondent of *The Engineer* says: "Trials, which appear to warrant success, have been made here for hardening or consolidating petroleum and naphtha, for the convenience of overland transport. The material—at present kept secret—by which this is accomplished is a well-known commercial article. It is true that it costs two and a-half times as much as the petroleum; but it is not lost by the process, as it is regained. The advantages claimed are that no evaporation takes place, and, consequently, that no explosions can occur, and that there is a great gain in freight; for instance, between Hamburg and Vienna, 70 per cent."

**A bridge** which recently gave way on the Brattleboro & Whitehall road in Vermont, is to be replaced by a heavier one, built by the Vermont Construction Company, of St. Albans, Vt. The road is narrow-gauge, and the bridge which failed was designed to carry rolling-stock of the lightest kind. As has been the case on some other roads of this kind, however, the weight of the equipment was gradually increased until the cars were made to carry loads nearly as heavy as standard-gauge cars, the result being a serious accident from the failure of the bridge. The company has taken warning, and a second bridge, which is still in use, is also to be replaced by a heavier structure.

**Water Rights in New Jersey.**—It is a fact not generally known that for some time past there has been quietly going on a process of absorption of the water rights of the mountain lakes and streams of Northern New Jersey. Much of this has been done under a general law of the State, authorizing the formation of water companies, and it has been done, probably, largely with a view to the future profit which is sure to accrue to the owners of the water supply which will, at no distant day, be needed by the many towns and villages of that section of the State. Nearly all of them are growing rapidly, and very few have a supply of water at all suited for their future needs.

**An Extraordinary Accident** occurred on board the Red Star steamship *Westernland* upon her recent voyage from Antwerp to New York. A double sea rose in front of the vessel, came up over her bows, and down in a solid mass upon the middle of the forward turtledeck, breaking it in and killing six persons—four sailors and two immigrant passengers—and injuring more or less seriously fourteen others, six of them sailors. She sailed from Antwerp on November 20, under command of Capt. Randle, with 69 cabin and 574 steerage passengers. A subscription of 2,000 francs was made by the passengers for the benefit of the families of the men who were killed.

**Electric Lights in Collieries.**—In the collieries of Wales, the correspondent of *The Engineer* says there has lately been considerable growth of the use of the electric light. It was first tried at the Mardy Colliery, and lately introduced to the stables and main levels of one of the Plymouth company's pits. Now the whole question has been brought in a masterly manner before the notice of the South Wales Institute of Engineers, by Mr. Hann, one of the Powell Duffryn managers. Mr. Hann's theory was to have no naked light in the colliery at all, but to light the miners' lamps by electricity from accumulators in the colliery. The meeting listened favorably to the details of the patent, and it was decided by several coal-owners present to try the plan.

**Steamless Road Locomotives.**—In order to render invisible the escape steam of tramway and other locomotives, Mr. R. C. Parsons, of Leeds, provides in a boiler of the locomotive type two sets of tubes, the one set of comparatively small diameter, and the other set of larger diameter, each set being capable of being more or less closed at the smoke-box end of the boiler by suitable slides or valves under the control of the driver. When the driver observes that the steam issuing from the chimney is more or less visible, he closes more or less the small tubes and opens more or less the large tubes, thus admitting to the smoke-box a greater amount of heat from the fire, which has the effect of rendering the steam invisible.—*Industrial Review.*

**Boston Passenger Stations.**—An important engineering work now under consideration in Boston is the consolidation and rearrangement of the passenger stations for the railroads entering the city from the north, the principal objects being to provide increased accommodations and to avoid the numerous crossings now existing, where the roads cross each other at grade. No definite plan has yet been adopted, but it is suggested that a new station for the Boston & Maine and the Eastern roads be built at Haymarket Square, with an entrance by elevated tracks, and that the existing Boston & Lowell station be utilized. There are many conflicting interests, and the work of preparing plans to unite all is not an easy one.

**Deflection of Railway Bridges.**—A novel method of measuring the deflection of railway bridges has been tried in Russia. An iron pipe 1½ in. in diameter was carried along the outside of one girder. From this pipe, at each abutment, at the pier, and at five intermediate points on each span, vertical pipes of the same diameter branched out. Inside, and near the top of each vertical pipe, was fixed a graduated ¾ in. glass tube, the iron pipe being cut away on both sides. The zero divisions on the tubes were all the same distance above the flange of the girder. Before the bridge was loaded the apparatus was filled with water, the tops of the upright pipes covered over, and the water was then drawn off until it stood at zero in each gauge. On the bridge being loaded the deflection could be read with ease.

**Cable Road for Third Avenue.**—It has been decided by the directors of the Third avenue horse railroad in New York to lay a cable for the whole of their lines. Those directors who had been somewhat favorably disposed toward electrical motors agreed that these, though desirable, were not yet in shape for practical use and that the cable was the most available system for the present. Even if electricity should be found suitable for use a few years hence, they said the substitution of it for the traction system could be easily accomplished. It was agreed that before deciding upon any particular style of road a committee should make a careful study of the matter, visit Philadelphia, Chicago, San Francisco and all other large cities employing the cable system, and report to the board. Robert W. Tailer, William Remsen and Silvanus S. Riker were appointed on this committee, and they will enter upon their duties at once. To change the line as the company proposes to do will cost about $1,500,000.

**The Tay Bridge**, according to the report of the North British Railway, is nearly completed. The plans of Mr. Barlow, as engineer, were approved by the directors in March, 1881, the fall of the original bridge having happened on December 28th, 1879. The new bridge provides four spans of 245 feet each, for the navigation of the river, with a clear headway of 62 feet instead of 88 feet as in the old bridge; the bridge is on a uniform gradient of 1 in 180, while the old bridge had gradients as sharp as 1 in 74. North of the navigable spans are now 18 spans, instead of 9 as formerly, with the track above the girders. The piers are concrete and brickwork up to 8½ feet above high water, and above that they are made of riveted wrought-iron; the bridge terminates at each end in brick arches. The contract for the new viaduct was let in 1882; the total expenditure on the new work, including the removal of the wreck and old piers, will not fall short of $5,000,000.

**The Lappin Brake Shoe Company** has been organized with a capital of $1,000,000, to manufacture the Lappin brake shoe and improved Christie head. Its officers are W. F. Collins, president; Thomas Milburn, treasurer, and W. S. Dehart, secretary. A foundry, 80 x 100 feet, is nearly completed at Bloomfield, N. J., and it is expected to begin to fill orders in a few weeks. The shoe is cast in one piece, but with alternating sections of chilled and soft iron. The soft sections, when cast, project about ¼ inch beyond the hard sections. The soft portions take the first wear, and as they wear down the shoe becomes accurately fitted to the wheel. The chilled sections give the shoe great durability. In the improved Christie head the four bearing points of the head are cast on a stationary chill. This case-hardens the bearings, producing increased durability. It also insures uniformity. The foundry will have a capacity of 25 tons per day, and it is intended to erect other foundries at the larger railway centers throughout the country. The offices of the company are at 239 Broadway, New York.

**The Old Colony Railroad Company,** in its last annual report, notes the fact that the heaviest expenditures for improvements during the year, have been made with the view of dispensing with highway grade-crossings. At several points the grade of the highways has been changed and bridges built over the track, while at one point a road is to be carried under the track, at a considerable expense. Other Massachusetts roads are doing some work in the same direction, but the Old Colony is, apparently, the first company to fully recognize and accept the fact that, in a thickly settled section like Eastern Massachusetts, grade-crossings are a dangerous nuisance, which cannot be permitted to exist much longer. The Massachusetts Railroad Commissioners have taken this view for several years past, and have, so far as their powers extended, steadily refused to authorize new grade-crossings, and have urged the abolition of existing ones wherever possible

**The Pennsylvania Railroad Company** has prepared plans for the elevation of its passenger tracks through Jersey City, with a view to the abolition of the many dangerous street-crossings in that city. From the eastern end of the cutting through Bergen Hill, an iron viaduct, about 25 feet above the street level, will carry the tracks to Henderson street. At this point the grade will begin to descend toward the ferry, and the road will be an earth embankment enclosed in masonry walls, the streets being carried underneath the embankment by arched tunnels. One street is to be closed entirely, provided the necessary authority is obtained. The company is ready to begin work on this improvement as soon as the City Council approves the plans. The only obstacle appears to be some local opposition to the closing of Greene street, but this street is already so blocked by the constant passage of trains and yard engines as to be passable only with much delay and great danger. No plan can be devised for keeping it open which does not require the raising of the passenger station and yards, the expense of which would be so enormous as to make it impracticable.

**Water Supply of Newark.**—The cities of Newark and Jersey City, N. J., which draw their water supply from the Passaic River, are not at all satisfied with the present condition of affairs. There has been in existence for some time a Joint Board on Water Pollution, appointed by the Water Commissioners of the two cities, and this Board reports increasing trouble with manufacturers and others. The Passaic supply is abundant in quantity, but the existence of the large city of Paterson on the river, only some 10 miles above the point where the Newark and Jersey City supply is taken, and the presence on the river and its tributaries of many manufacturing villages and a dense population, make it a difficult matter to prevent such pollution of the water as shall render it altogether unfit for use. The upper water-shed of the Passaic is a mountain region, which gives a water supply of excellent character; the trouble arises altogether from the large population of the country bordering on the lower portion of the river. Many plans have been proposed for avoiding the present difficulty, but unfortunately no other supply is available for the cities, which does not require the construction of long aqueducts at a great expense.

**Inspection of Boilers in the British Navy.**—According to the new instructions of the Admiralty, boilers of all ships in commission are to be examined and drill-tested from time to time during the commission, by an engineer officer other than the officer in whose charge they are. The detailed results of the examination, together with a statement showing the previous treatment of the boilers, are to be forwarded to the Admiralty. Copies are also to be furnished to the inspector of machinery on the station and to the chief engineer of the flagship. Unless the examining officer thinks it necessary, not more than one boiler in four need be drilled for thickness, preference being given to those which are deemed to be most worn; but all the boilers are to be examined, and separate detailed reports are to be forwarded for each boiler drilled. Should there be any defects in the boilers, internal or external, or symptoms of corrosion, the report is to state what they are, and the steps that are being taken to make good the defects or arrest corrosion. The boilers are to be drilled during the time the ship is in commission at intervals of not less than eighteen months, nor more than two years, and the first drill test is to be made as soon as convenient after the ship has been eighteen months in commission. When a ship is ordered to be commissioned her boilers are to be drilled either before she is commissioned, or as soon afterwards as may be convenient. The boilers of ships attached to the home ports, where there is a Steam Reserve, will be drill tested by the officers of the Steam Reserve. The boilers of ships of the First Reserve will be drill tested by the dockyard officers, when in hand for the annual reft.

## PERSONALS.

**Mr. H. R. Holbrook** has been appointed Chief Engineer of the projected Pueblo & Eastern road. His office is at Pueblo, Col.

**Mr. Eliot C. Clarke,** recently Chief Engineer of the Massachusetts Drainage Commission, has been appointed Treasurer of the Booth Cotton Mills, at Lowell, Mass.

**Mr. Charles W. Irish,** a railroad engineer of long experience, has been appointed by the President, Surveyor General of Nevada.

**Prof. Rossiter W. Raymond** has been appointed as an expert to examine the lighting and ventilation of the new Croton Aqueduct tunnel.

**Mr. George R. Hardy,** late of the Boston & Albany, has been appointed Assistant Chief Engineer of the Lake Shore & Michigan Southern road.

**Mr. Walter S. Keen** is appointed Engineer of the Western Division of the Norfolk & Western road, in place of Mr. H. H. G. Handy, assigned to other duty.

**Mr. Thomas B. Russam,** late chief draughtsman, is now acting Master Mechanic of the Central Railroad of New Jersey, in place of William Woodcock, deceased.

**Mr. Robert Narland Brown,** at one time Assistant Engineer, and afterward Division Superintendent of the Erie Railway, died Nov. 16, at Wiesbaden, Germany, aged 70 years.

**Col. James Boon,** an extensive railroad contractor, and father of Mr. James M. Boon, Superintendent of Motive Power of the West Shore road, died in Lancaster, Pa., Dec. 13, aged 83 years.

**Mr. Walter Shepard,** has been appointed Assistant Chief Engineer of the Boston & Albany road, to succeed Mr. George R. Hardy, who has gone to the Lake Shore & Michigan Southern.

**Mr. E. F. Smith** has been appointed Superintendent and Engineer of Canals of the Philadelphia & Reading Railroad Company. There has been a regular change and reassignment among the division engineers of that company.

**Mr. John A. Grant,** formerly Chief Engineer, and for a time General Superintendent of the Louisville, New Orleans & Texas road, has been appointed General Manager of the Texas & Pacific in place of George Noble, deceased.

**Mr. L. B. Davies,** now a resident of Columbus, O., claims to have designed and put in use the first locomotive pilot or cow-catcher of the pattern now generally adopted. His first pilot was put on an engine on the Columbus & Xenia road in 1853, Mr. Davies being at that time Master Mechanic of the road.

**Mr. J. G. Osborne,** formerly Assistant Engineer, and lately Trainmaster of the New River Division of the Norfolk & Western road, has been relieved of his duties and placed in charge of a preliminary survey for an extension of the line to the Ohio River.

**Mr. John B. Root,** the inventor of the Root sectional boiler and of other mechanical devices, died at his residence in Portchester, N. Y., December 11th, aged 56 years. Mr. Root was an active member of the American Society of Mechanical Engineers.

**Mr. Jacob Johann,** First Vice-President of the Master Mechanics' Association, and one of its best-known members, leaves the Chicago & Atlantic road to become Superintendent of Motive Power and Rolling Stock of the Texas & Pacific. Mr. Johann's office will be at Marshall, Texas.

**Mr. Alfred W. Fiske,** who died in Pottsville, Pa., Nov. 30, aged 66 years, was for a number of years Manager of the Fishbach Rolling Mill and the Pioneer Furnace at Pottsville. He was, from 1868 to 1873, General Manager of the Northern Central Railway.

**Mr. Gilbert C. Breed,** who died in Louisville, Ky., Nov. 17, was for many years a railroad engineer. His first service was in New York, where he was employed in the location and building of the Rochester & Niagara Falls, and other lines. Subsequently he was assistant engineer in the location of what is now the main line of the Wabash, and in 1856, went to Kentucky, where he became Chief Engineer of the Memphis, Clarksville & Louisville road, now part of the Louisville & Nashville. He was also connected for a time with the Nashville & Decatur, and the Nashville, Chattanooga & St. Louis roads. For some ten years past his work has been in the operating department entirely, and some months ago he retired from work altogether.

# Manufactures.

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## THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

THIS company has just published a new descriptive catalogue of locomotives built in its shops, which contains an account of the origin and history of this establishment, and of what may be called the mechanical evolution of the locomotive in these works. The first portion of this has been reprinted from advanced sheets in the AMERICAN RAILROAD JOURNAL during the last half of 1886. Owing to the consolidation of that journal with *Van Nostrand's Engineering Magazine*, it has been thought desirable to republish that portion of the history and origin of the Rogers Locomotive & Machine Works, which has already appeared in the AMERICAN RAILROAD JOURNAL, in the consolidated publication, in order that all its readers may have the history complete.

### CHAPTER I.

THE Rogers Locomotive and Machine Works were founded by Thomas Rogers, who was born March 16th, 1792, in the town of Groton, in New London County, Connecticut. He died in New York City, April 19th, 1856. He served in the war of 1812, and was a lineal descendant of Thomas Rogers, one of the Pilgrim Fathers who came over to this country from England in the Mayflower. At the age of sixteen he was apprenticed to learn the trade of a house carpenter, and in the summer of 1812 he removed to Paterson, N. J., then a small village, which at that time was very prosperous on account of the demand for American manufactures brought about by the war with Great Britain.

At this time, he was employed as a journeyman carpenter, and was noted for his constant application to business, good judgment, and force of character. A few years afterward, Captain Ward, who had been traveling in Europe, where he had seen the power-loom in operation, came to Paterson for the purpose of introducing the manufacture of cotton duck. Mr. Rogers was employed to make the patterns for these looms. He very soon understood their construction and recognized their value, and bought from Captain Ward the patent-right for making them.

In 1819, he associated himself with John Clark, Jr., under the firm name of Clark & Rogers. They commenced work in the basement story of the Beaver Mill, a building which at an early day had been put up by Mr. Clark's father. Shortly afterwards, Mr. Rogers visited Mexico, where he received large orders for looms, etc. In 1820, the firm moved into the little Beaver Mill, and in the following year took into partnership Abraham Godwin, Jr., and the firm name was then changed to Godwin, Rogers & Co. They then commenced spinning cotton, and building machinery for that and other purposes.

In 1822, finding their accommodations too limited, they leased Collett's Mill and moved into it. Their business continued to increase, the number of persons employed being sometimes as high as 200. The establishment continued to prosper until the summer of 1831. In the latter part of June of that year Mr. Rogers withdrew, and took with him $38,000 as his share of the profits of the firm.

He then took a mill-site on the upper raceway in Paterson, and immediately commenced the erection of the "Jefferson Works," which were finished and put in operation before the close of the following year. The location and building of the "Jefferson Works" was literally an encroachment on the forest. On the upper race no factories had been put up, except two little cotton mills and a small machine shop, the latter owned by Messrs. Paul & Beggs. Between Spruce and Mill streets, all was swamp covered with pines.

It was the intention of Mr. Rogers to devote the lower stories of the "Jefferson Works" to building machinery, and the upper stories to spinning cotton. The latter was, however, never commenced, as the demand for machinery increased so fast that the whole of the new building was devoted to that branch of the business.

In the early part of 1832, he associated with himself Messrs. Morris Ketchum and Jasper Grosvenor, of New York, the name of the firm being Rogers, Ketchum & Grosvenor.

In that year the railroad from Jersey City to Paterson was approaching completion, and the iron work for the bridges over the Passaic and Hackensack rivers had been made by Mr. Rogers. An order was also executed for one hundred sets of wheels and axles for the South Carolina Railroad, of which Mr. Horatio Allen was the chief engineer. A short time before, Mr. Allen had visited England to get information about the use of locomotives on railroads, and at the time he ordered the work for the South Carolina Railroad he recommended Mr. Rogers to undertake the construction of locomotives.

In the following letter, written more than fifty years after the event, Mr. Allen describes his interview with Mr. Rogers:

"SOUTH ORANGE, N. J., December 31st, 1884.

"DEAR SIR:—The earliest railroad work in this country was done by the West Point Foundry Association, to which was entrusted the order for railroad wheels for the South Carolina company, and other work for that company.

"Knowing that the era that had opened would require works specially appropriate to the construction of the rolling-stock up to the locomotives, I obtained authority, in the spring of 1830, from the South Carolina Railroad company, to seek the works which, in position, instrumentalities, and preparedness, were in condition to undertake and were willing to undertake what was wanted.

"The result of inquiries to the end in view led me to call on Rogers, Ketchum & Grosvenor, a firm then engaged in the manufacture of machinery for cotton and woolen mills, whose works were at Paterson, N. J.

"At these works I called, and asked an interview with Mr. Rogers, the partner having charge of all the mechanical operations of the firm. It was without any letter of introduction or any personal knowledge of each other. My subject was my introduction, and Mr. Rogers very soon led me to know that I had come to the right place and to the right man.

"At the close of an hour's conversation Mr. Rogers expressed his readiness to enter the new field, and to undertake any orders that were entrusted to the firm. The future of 'The Rogers Locomotive Works' was determined at that hour's conversation.

"The personal and business relations which followed this interview continued for many years, and were to me of the most satisfactory character.

"Yours truly, HORATIO ALLEN."

### CHAPTER II.

#### THE EARLY HISTORY OF RAILROADS IN THIS COUNTRY.

In 1833, railroads were already attracting a great deal of attention in this country. The opening of the Erie Canal for commercial purposes in 1826, and the consequent diversion of traffic from other seaboard cities to New York, led the people of Philadelphia, Baltimore, Boston and Charleston to seek for means by which their lost trade could be recovered. Investigation and accurate surveys soon showed the impracticability of constructing canals from Baltimore to the Ohio river, or from Boston to the Hudson. In the meanwhile, information concerning the successful use of steam-power on the Stockton & Darlington Railroad in England, which was opened in 1825, had reached this country, and the public had received the reports of the celebrated experiments with locomotives which were made on the Liverpool & Manchester Railway in 1829. As Mr. Charles Francis Adams, Jr., has expressed it:*

"America suffered from too few roads; England from too much traffic. Both were restlessly casting about for some form of relief Accordingly, all through the time during which Stephenson was fighting the battle of the locomotive, America, as if in anticipation of his victory, was building railroads....

"The country, therefore, was not only ripe to accept the results of the Rainhill contest, but it was anticipating them with eager hope"

After the experiments referred to had been made, full reports giving in detail their results were published in this country, committees of inquiry were sent to England to get information and report on the railroads of that country, and a railroad mania began to pervade the land.

The first railroad which was built in the United States was a short line of about three miles, from the Quincy granite quarries to the Neponset river, † for the transportation of granite for the Bunker Hill monument. This was merely a tram road, and was operated by horse-power and stationary engines, and was built in 1826. As Mr. Adams says:

"Properly speaking, however, this was never—or at least, never until the year 1871—a railroad at all. It was nothing but a specimen of what had been almost from time immemorial in common use in England, under the name of 'tramways.'"

A similar work was constructed at about the same time for the transportation of coal from the pit's mouth to the Lehigh Valley Canal near Mauch Chunk, Pa.

In the latter part of 1827, the Delaware & Hudson Canal Company put the Carbondale Railroad under construction. This road extends from the head of the Delaware and Hudson

* See "Railroads: their Origin and Problems."

† It has recently been stated that as early as 1809 an experimental railroad track, 180 feet in length, was laid in Delaware County, Pa., and that in the same year a road about a mile long was constructed from stone quarries on Crum Creek to a "landing" on Ridley Creek in the same county and State. The evidence upon which this statement is based has not been made public.

Canal at Honesdale, Pa., to the coal mines belonging to the Delaware & Hudson Canal Company at Carbondale, a distance of about sixteen miles. This line was opened, probably, in 1829, and was operated partly by stationary engines, and partly by horses. The line is noted chiefly for being the one on which a locomotive was first used in this country. This was the "Stourbridge Lion," which was built in England under the direction of Horatio Allen, then an assistant engineer on this line. It was tried at Honesdale, Pa., in August, 1829.

According to "Poor's Railroad Manual for 1876 and 1877": "It was not until 1828, that the construction of a railroad was undertaken, for the transportation both of freight and passengers, on anything like a comprehensive scale. The construction of the Erie Canal had cut off the trade which Philadelphia and Baltimore had hitherto received from the West; and as the project of a canal from the city of Baltimore to the Ohio was regarded by many as impracticable, the merchants of that city, in 1827, procured the charter of the present Baltimore & Ohio Railroad. On the 4th of July, 1828, the construction of the railroad was begun, the first act being performed by the venerable Charles Carroll, of Carrollton, the only then surviving signer of the Declaration of Independence. At the close of the ceremony of breaking ground, Mr. Carroll said: "'I consider this among the most important acts of my life, second only to that of signing the Declaration of Independence, if even second to that.'

"In the fall of 1829, the laying of the rails within the city of Baltimore was begun. On the 22d of May, 1830, the first section of fifteen miles, to Ellicott's Mills, was opened.

"The next important railroad was the South Carolina,* begun in 1830, and opened for traffic in 1833 for its whole length (135 miles). At that time, it was the longest continous line of railroad in the world. The construction of the Mohawk & Hudson Railroad, now a part of the New York Central, was begun in 1830. It was opened (17 miles) in 1831. The Saratoga & Schenectady Railroad (21½ miles) was opened in the following year; the Paterson & Hudson River Railroad was chartered in January, 1831, construction on it was commenced in 1832, and it was opened in 1834; the Cayuga & Susquehanna (34 miles), connecting the Susquehanna river with the Cayuga Lake, was opened in 1834; and the Rensselaer & Saratoga (25 miles) in 1835. In New Jersey, that portion of the Camden and Amboy extending from Bordentown to Hightstown (14 miles) was opened on the 22d of December, 1832; and between Hightstown and South Amboy (47½ miles) in 1834. In Pennsylvania, a considerable extent of line for the transportation of coal had been constructed previous to 1835. In 1834, the Philadelphia & Columbia (82 miles) and the Portage Railroad (36 miles), both forming a part of the system of public works undertaken by the State of Pennsylvania, were opened. The completion of these gave that State a continuous line, made up of canal and railroad, from Philadelphia to the Ohio River at Pittsburgh. The total mileage of railroad constructed in the State of New York up to, and including, 1835, was 265 miles, or more than one-quarter of the whole extent of line then in use in the United States. In 1833, the Baltimore & Ohio Railroad was extended as far west as Harper's Ferry (81 miles). In the same year the Washington branch (30 miles) was also completed. In Massachusetts, in 1835, the Boston & Worcester Railroad (44 miles), the Boston & Providence (41 miles), and the Boston & Lowell (26 miles) were all opened for business. The total mileage in operation in all the States at the close of that year was 1,098 miles."

The preceding sketch of the early history of railroads in this country, is given to show the extent of railroad construction at the time that Mr. Rogers determined to undertake the manufacture of locomotives.

## Chapter III.

### The Early History of Locomotives in This Country.

In the latter part of the year 1827, the Delaware & Hudson Canal Company decided to have built in England three locomotives, for their line of railroad from Honesdale to Carbondale. This action was taken on the report of the chief engineer of the road, Mr. John B. Jervis; and Mr. Horatio Allen, then a resident engineer on the line, was deputized to go to England and have the engines built on plans to be decided by him when in England. He arrived there early in 1828, and ordered one engine from Foster Rastrick & Co., of Stourbridge. This was the "Stourbridge Lion" (Fig. 2). Two other engines were ordered from Stephenson & Co., Newcastle.

In a pamphlet with the title "The Railroad Era," written by Mr. Allen in 1884, he says:

"The two locomotives from Stephenson that were in New York early in the year 1829, and therefore prior to the trial of the locomotive 'Rocket' in October of that year, were identical in boiler, engines, plan and appurtenances with the 'Rocket' (Fig. 3); and if one of the two engines in hand ready to be sent had been the one used on August 9th, 1829, the performance of the 'Rocket' in England would have been anticipated in this country.

"The three locomotives were received in New York in the winter of 1828 and 1829. One of each kind was set up, with the wheels *not* in contact with the ground, and steam being raised, every operation of the locomotive was fully presented, except that of onward motion."

None of these engines were sent to the road for which they

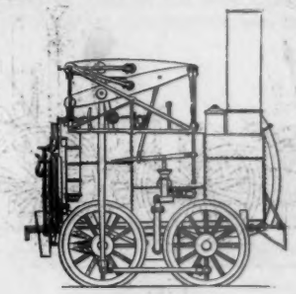


Fig. 2.

were intended, until the following spring. The "Stourbridge Lion," so far as is known, was the only one which was ever placed on the road. It was not tried until August 9th, 1829, and was then run by Horatio Allen, who has the honor of being the first person who ever ran a locomotive in America.

This engine, it was said, was too heavy for the road, and was used only a short time. It is a singular fact that it is not now

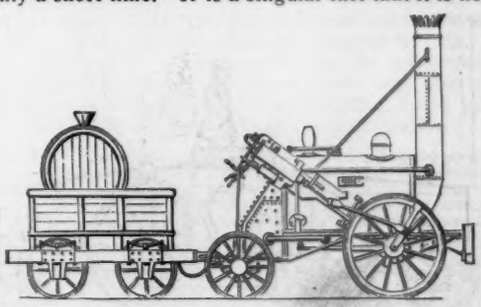


Fig. 3.

(1886) known what became of the two engines built by Stephenson & Co., and which were in every essential similar to the celebrated "Rocket."

In August, 1830, Peter Cooper tried his 'model of experimental locomotive engine" (represented by Fig. 4) on the Baltimore & Ohio Railroad. This engine had but one working cylinder of 3¼ inches diameter, and 14½ inches stroke of pis-

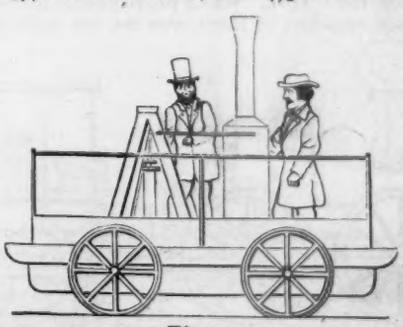


Fig. 4.

ton. The engine was tried on August 28th, 1830. In the same year, the South Carolina Railroad Company contracted with Mr. E. L. Miller to build a locomotive, which was named the "Best Friend," for the South Carolina Railroad Company. This engine (shown by Fig. 5) was put into service in November, 1830, and was the first locomotive ever built in America for actual service upon a railroad.

A locomotive called "The South Carolina" (Fig. 6), designed by Horatio Allen, was built for the South Carolina Railroad by the West Point Foundry Association, in the year 1831. The boiler had its fire-box in the middle, with a pair of

*The original charter of the South Carolina Railroad was granted December 19th, 1827. This was not satisfactory to some of the citizens of Charleston, and a new bill was reported to the legislature on the 22d of January, 1828, and passed on the 29th of the same month. The stockholders organized as a company on the 12th of May, 1828.

barrels (four in all) extending each way, with a chimney at each end. The engine had eight wheels, arranged in two trucks, one pair of driving-wheels, and one pair of leading wheels forming a truck. Each truck had one cylinder, which was in the middle of the engine and attached to the smoke-box. The driving axle had a crank in the middle to which the connecting rod was attached by a ball-joint. The trucks were connected to the engine by king-bolts in the usual way.

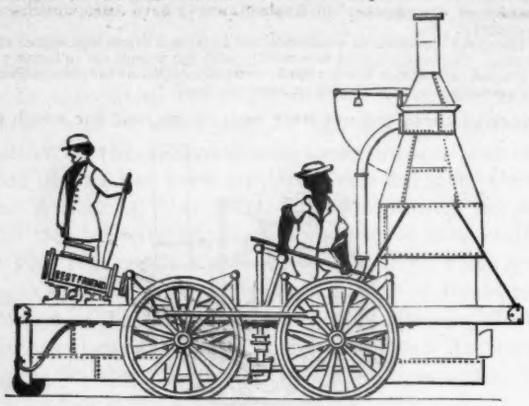


Fig. 5.

The "De Witt Clinton" (Fig. 7) was the third locomotive built by the West Point foundry Association. It was made for the Mohawk & Hudson Railroad, and was ordered by John B. Jervis, Esq. The first excursion trip with passengers, drawn by the "De Witt Clinton," was made from Albany to Schenectady, August 9th, 1831.

On January 4th, 1831, the Baltimore and Ohio Railroad offered the sum of $4,000 "for the most approved engine

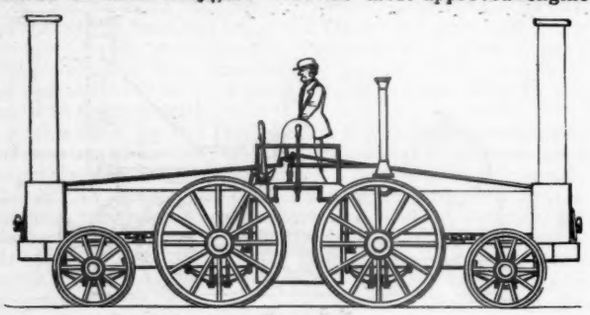


Fig. 6.

which shall be delivered for trial upon the road on or before the 1st of June, 1831—and $3,500 for the engine which shall be adjudged the next best."

Three or four locomotives, amongst them one with a rotary engine, built by Mr. Childs, of Philadelphia, entered into the competition during the summer of 1831. The only one of them, named the "York," which proved equal to the moderate performance required of them, was the one built by Messrs.

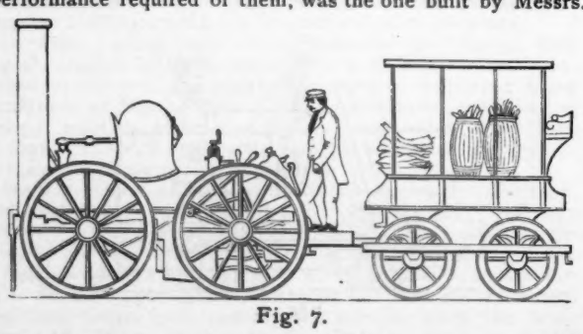


Fig. 7.

Davis & Gartner, two machinists of York, Pa. The engines had a vertical boiler and vertical cylinders, with four coupled wheels 30 inches in diameter. It was altered considerably after being placed on the road. The "Atlantic" was afterwards built by the same firm, and was the first of what were afterwards known as the grasshopper engines (Fig. 8), which were used for many years on the Baltimore & Ohio Railroad.

In August, 1831, the locomotive "John Bull" (Fig. 9), built by George & Robert Stephenson & Co., of Newcastle-upon-Tyne, was received in Philadelphia for the Camden and Amboy Railroad and Transportation Company. This is the old engine which was exhibited at the Centennial Exhibition in Philapelphia in 1876. In the winter of 1831 or 1832, three locomotives built by the same firm in England were received, and were put to work on the Newcastle & Frenchtown Railroad in Delaware.

The third edition of "Wood's Treatise on Railways," published in 1838, contains a tabular statement which gives the names and dimensions of engines built by R. Stephenson & Co., Newcastle-upon-Tyne, and the names of the railways for

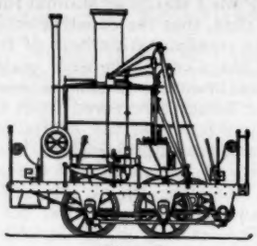


Fig. 8.

which they were built. This table contains the names of the following locomotives for American roads:

"Delaware," for Newcastle & Frenchtown Railroad.
"Maryland," " " " "
"Pennsylvania," " " "
"No. 42," for Saratoga & Schenectady Railroad.
"H," and "Mohawk," for Mohawk & Hudson Railroad.
"Stevens," for New York.
"No. 52," for United States.
"Edgefield," for Charleston & Columbia Railroad.

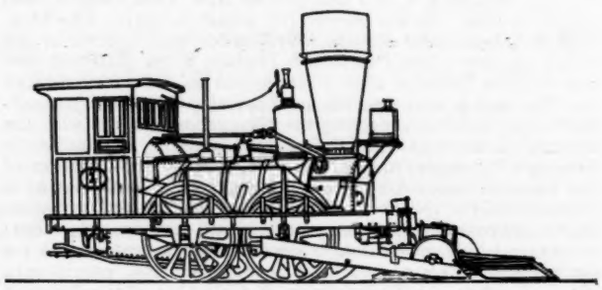


Fig. 9.

"Brother Jonathan," for Mohawk & Hudson Railroad.
"No. 61." " " " " "
"No. 75," for Saratoga & Schenectady Railroad.
"Wm. Aiken," for Charleston & Columbia Railroad.
"No. 99," " " " " "
"No. 104," for Pennsylvania Railroad.
"No. 105," " " "
"No. 106," " Columbia "

No dates are given in the table, but all of these sixteen engines must have been built before 1838. Most of them were

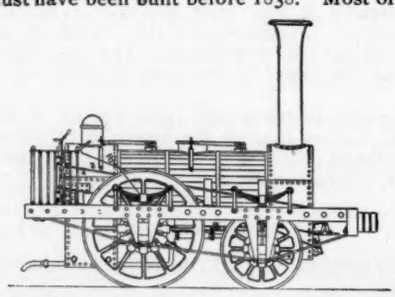


Fig. 10.

probably of what was known as the "Planet" class (shown by Fig. 10), which is the form of engine that succeeded the "Rocket," and the only one which the Stephensons built for some years after its adoption. These locomotives, which were imported from England, doubtless, to a very considerable extent, furnished the types and patterns from which the engines which were afterwards built here were fashioned. But American designs very soon began to depart from their British prototypes, and a process of adaptation to the existing conditions of the railroads in this country followed, which afterwards "differentiated" the American locomotives more and

more from those built in Great Britain. Until recently, a marked feature of difference between American and English locomotives has been the use of the truck under the former. Its use was proposed by Mr. Horatio Allen, in a report, dated May 16th, 1831, which he made to the South Carolina Canal & Railroad Company, of which he was then the chief engineer. The locomotive with two trucks (shown by Fig. 6) was built from his design in the latter part of 1831, and was put into operation on the South Carolina Railroad in the early part of 1832. In the latter part of the year 1831, the late John B. Jervis invented what he called "a new plan of frame, with a bearing carriage, for a locomotive engine, for the use of the Mohawk & Hudson Railroad (represented by Fig. 11), which was constructed and put on the road in the season of 1832."

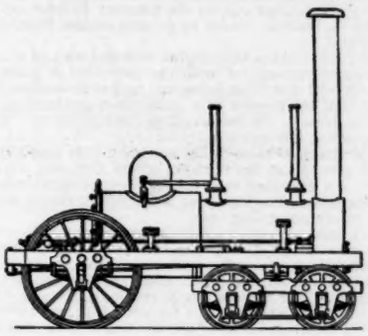


Fig. 11.

A truck was also devised by Ross Winans and applied to a locomotive on the Baltimore & Susquehanna Railroad (now the Northern Central) in the latter part of 1832. In a letter published in the AMERICAN RAILROAD JOURNAL of July 27th, 1833, Mr. Jervis describes the objects aimed at in the use of the truck, as follows:

"The leading objects I had in view, in the general arrangement of the plan of the engine, did not contemplate any improvement in the power over those heretofore constructed by Stephenson & Co.;* but to make an engine that would be better adapted to railroads of less strength than are common in England; that would travel with more ease to itself and to the rail on curved roads; that would be less affected by inequalities of the rail than is attained by the arrangement in the most approved engines."

The effectiveness of the truck in accomplishing what it was intended for was at once recognized, and its almost general adoption on American locomotives followed.

In the year 1833, Judge Dickerson, then president of the Paterson & Hudson River Railroad, ordered a locomotive, which was called the "McNeill," from George Stephenson, which was to be as good as possible, without regard to cost. It arrived and was put in operation in the year 1834. The cylinders were 9 inches diameter by 18 inches stroke, and the engine had one pair of driving-wheels five feet in diameter, which were behind the fire-box. The axle was cranked, and the cranks were close to the wheels; there was room for the connecting rods to pass by the outside of the furnace. The front end was supported by a four-wheeled truck; the fire-box and tubes were of copper. The engine continued in use many years and was said to be very fast, and was finally sold to a western railroad, the business of the Paterson & Hudson River Railroad having grown beyond the engine's capacity.

There may have been other English engines, of which there is no record, imported into this country about this time, but, as already stated there is no doubt that to a very considerable extent the English engines were the models from which American designers received many suggestions; but, as will be shown, they very soon began to depart from the original types, and the development of the locomotive here was quite distinct from that which it had in Europe.

## CHAPTER IV.

### HISTORY OF LOCOMOTIVE BUILDING AT THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

PREPARATION for locomotive building in Paterson had been made as early as 1833 by Messrs. Paul & Beggs, in their shop near that of Mr. Rogers. They had a small engine nearly completed when their building took fire and was consumed, and the locomotive destroyed.

In 1835 some buildings were begun by Messrs. Rogers, Ketchum & Grosvenor, with a view to the manufacture of locomotives.

The first locomotive, the "Sandusky," Fig. 12, which the firm built, was not completed until 1837. It was intended for the New Jersey Railroad & Transportation Company. The engine was 4 feet 10 inches gauge, the same as that of the line for which it was built. It had cylinders 11 inches diameter by 16 inches stroke, with one pair of driving-wheels of 4 feet 6 inches diameter, which were placed in front of the fire-box. The engine had a truck in front, with four 30-inch wheels. The cylinders were inside the frames and were connected to a crank-axle of the form shown in Fig. 13. The eccentrics were outside of the frame, and the eccentric rods extended back to rocking-shafts which were located under the foot-board. The smoke-pipe was of the bonnet kind, and had a deflecting cone in its center. The edges of the cone were curled over so as to deflect the sparks downward, and thus prevent their passing through the wire bonnet, as well as preventing the bonnets from wearing out too fast.

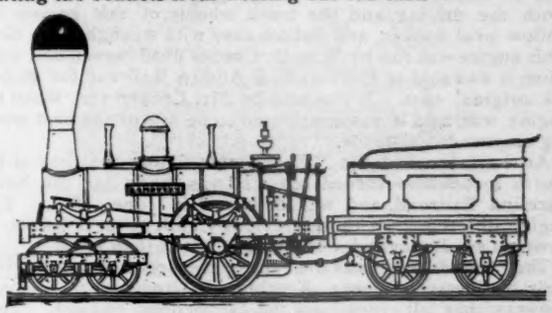


Fig. 12.

The driving-wheels of the engine were made of cast-iron, with hollow spokes and rims, which at the time was a remarkable novelty. The section of the spokes was of an oval form, and the rim of very much the same shape as that which is in common use at the present time. This kind of driving-wheel has since come into almost universal use in this country.

Another important improvement adopted by Mr. Rogers in the construction of this engine, was the counterbalancing the weight of the crank, connecting rods and piston. For this he filed a specification in the Patent Office, dated July 12th, 1837. It is described as follows in the specification:

"The nature of my improvement consists in providing the section of the wheel opposite to the crank with sufficient weight to counterbalance the crank and connecting rods, making the resistance of the engine less in starting and in running; also preventing the irregularity of motion caused by that side of the wheels when the cranks are placed in the usual mode of fitting them up. The irregular motion which arises from not having the cranks and connecting rods balanced, is attended with much injury to the engine, and to the road, and with much loss of power."

In order to counterbalance the weight of the parts referred to, the rim of the wheel opposite the crank was cast solid, while the other part of it was made hollow. The importance of counterbalancing was not recognized as being necessary until several years after it had been introduced by Mr. Rogers, and when attention was drawn to it, many doubted the necessity of balancing anything more than the cranks.

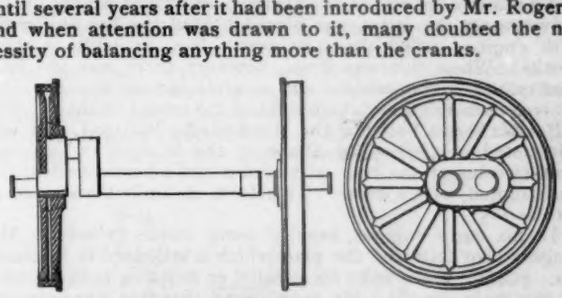


Fig. 13.

The trial trip of the "Sandusky" was made from Paterson to Jersey City and New Brunswick, and back, on the 6th of October, 1837, Mr. Timothy Smith acting as engineer. The performance of the engine was entirely satisfactory; the gauge of the road was 4 feet 10 inches, the same as that of the New Jersey Railroad & Transportation Company, for which road the engine was intended. It was, however, bought for the Mad River & Lake Erie Railroad by its President, Mr. J. H. James, of Urbana, Ohio, and, on the 14th, it was shipped via canal and lake, in charge of Mr. Thomas Hogg, in the schooner *Sandusky*. Mr. Hogg had worked upon it from the commencement. It arrived at Sandusky, Nov. 17th, 1837, at which time not a foot of track had been laid. The road was built to suit the gauge of the engine, and the Legislature of Ohio passed an Act requiring all roads built in that State to be of 4 feet 10 inches gauge, the same as the engine "Sandusky."

The engine was used in the construction of the road until

* The truck was applied by Mr. Jervis to an engine built by Stephenson & Co., of England.

the 11th of April, 1838, when regular trips for the conveyance of passengers commenced between Belleview and Sandusky, a distance of 16 miles.

The engineer was Thomas Hogg, who ran the engine for three years, keeping it in repair. It continued in service many years, until engines of larger size were required to do the work.

The second locomotive built by Mr. Rogers was called the "Arresseoh No. 2." It was completed in February, 1838, for the New Jersey Railroad & Transportation Company. It was similar in design to the "Sandusky."

The third engine was named the "Clinton," and was built for the Lockport & Niagara Falls Railroad Company, and was delivered to it in April, 1838. It differed from the first engines in having cylinders which were 10 inches in diameter and 18 inches stroke, and the gauge was 4 feet 8½ inches. Both the driving and the truck wheels of this engine had hollow oval spokes, and hollow rims with wrought-iron tires. This engine was run by Wm. E. Cooper until November, 1843, when it was sold to the Toledo & Adrian Railroad for $6,500, the original cost. It was said by Mr. Cooper that when the engine was sold it was considered to be one of the best working engines in existence.

An engine called the "Experiment," was the next or the fourth locomotive turned out. It was made for the South Carolina Railroad, and was delivered in June, 1838. This engine differed from those previously built at these works, in having a smaller cylinder and longer stroke than usual.

The "Sandusky" was the type of the first four locomotives built by Messrs. Rogers, Ketchum & Grosvenor. In many respects they all resembled the Stephenson engines. They had inside cylinders and a crank-axle, but differed from English locomotives chiefly in having a truck instead of a pair of

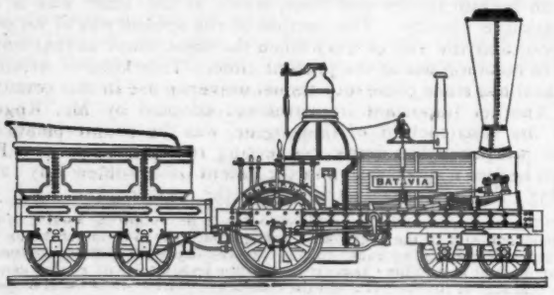



Fig. 14.

leading wheels. The driving-axles were in front of the fire-boxes, with the result that the overhang of the latter behind the axle brought an undue proportion of the weight of the engine on these axles.

To remedy the evil of an excessive amount of weight on the driving-axle, the latter was placed behind the fire-box in the fifth engine, called the "Batavia," Fig. 14, built at these works. When this was done, however, there was too little load on the driving-wheels, and an arrangement was provided for transferring part of the weight of the tender to them. The "Batavia" was built for the Tonawanda Railroad, and was completed in 1838. The shape of the furnace, in plan, was semi-circular at the rear part, and it had a hemispherical top surmounted with a dome. This form of fire-box was used as late as 1857.

In his early engines, besides using inside cylinders, Mr. Rogers also followed the plan which is still used in England, viz.: putting the cranks for parallel or coupling rods opposite to the main cranks. He soon found that this arrangement, while it had some advantages, such as requiring less counterbalance, caused the journals of the driving-axles to wear oval; he therefore adopted the plan of putting the cranks, for both main and outside rods, on the same side of the center of the axle.

The "state of the art" of locomotive building in this country in its infancy, is graphically described in the following articles, which appeared in the AMERICAN RAILROAD JOURNAL AND MECHANIC'S MAGAZINE of December 15th, 1839. In one of these the editor said:

"A few days ago, in company with one of the proprietors, we had the pleasure of a visit to, and inspection of the very extensive works of Messrs. Rogers, Ketchum & Grosvenor, at Paterson, New Jersey, for the construction of various kinds of machinery. Our attention was, of course, principally directed to the shops for the construction of locomotives, the main building of which is 200 feet long and three stories high, and another of equal length containing near 50 forges, most of which were in operation, notwithstanding the pressure of the times.

"We saw a number of engines in different states of forwardness, and though the general forms are those of 6-wheeled American engines in general, we were not a little gratified with several minor arrangements, new to us at least, which have been introduced by Mr. Rogers, and to which we shall briefly refer.

"The wire gauze of the smoke-pipe is protected by an inverted cone, placed in the axis of the pipe, a few inches below the wire gauze. The base of the cone is curled over so as to scatter the sparks over a large portion of the surface of the wire cloth, and to prevent the top of the spark-catcher from being burnt out before the rest of the wire cloth is materially injured; it also tends to throw the larger sparks down between the pipe and the casing, and will do something towards diminishing this standing reproach.

"The truck-frames, whether of wood or iron, were admirably stiffened by diagonal braces, and where the crank-axle is used, the large frame is very strongly plated in the manner of Stephenson's engines, the neglect of which till very lately has been, we are informed, a constant objection to the Philadelphia engines on the Long Island and Troy railroads.

"The wheels are of cast-iron, with wrought-iron tires; the spokes are round, and they, as well as the rims, are hollow, except where the crank-axle is used, when the rims are cast solid on one side so as to counterbalance the cranks.

"Our readers will probably remember an article on this subject in the JOURNAL, Nos. 7 and 8, page 244, of the present volume, on 'Side Motion or Rocking,' by G. Heaton, where its success on the Birmingham Railroad has been complete.

"Mr. Rogers balanced his first engine wheels two and a half years since, and entered a specification, not with the intention of taking out a patent, but to prevent anyone else from doing so; and thus deprive the community of the benefit which Mr. Rogers was desirous of conferring, and which we understand other makers are now availing themselves of. The advantages are fully explained in the article referred to.

"When the crank-axle is used, the eccentric rods and the cranks of the rock-shafts are placed on the outside, where they are easily got at, and where they are not crowded into the smallest possible space, as with the ordinary arrangement. For this, also, a specification was entered with the same object as in the preceding case.

"But we were most pleased with the arrangement of levers to which the eccentric rods are fastened, and thus the reversing depends on no contingency, for the rods are forced in and out of gear; a single handle only is required to manage the engine much more rapidly and efficiently than by the ordinary mode. The boilers are 8 feet long, for an 8-ton engine, and with 120 flues, the usual length of the former being, we believe, 7 feet, and the number of the latter about 80 or 90; by this deviation the area of heating surface is increased, and the heat remains longer in contact with the flues, while the addition to the weight is very trifling compared with the advantages derived from the saving of fuel.

"Mr. Baldwin, of Philadelphia, took out a patent some time since for a very ingenious mode of saving half the crank, by inserting the wrists into one of the spokes of the driving-wheels, and this has been very closely imitated by making one complete crank, and by letting one-half of it into a spoke which is cast larger than the others, with a receptacle for the purpose. This latter plan has been adopted by Mr. Rogers and others in this neighborhood, whilst the Boston machinists aim at bringing the two cranks as near together as possible. The relative merits of straight and cranked axles are so well pointed out in Mr. Wood's papers on locomotives in these numbers, that we shall merely beg leave to state that the plan of Mr. Baldwin and its imitation, appear to us to combine the liability to fracture of the crank-axle with the loss of heat, the exposure to accident, and the racking of frame and road ascribed to the straight axle, for the only difference is the thickness of the spoke; the loss of heat is the same in both, the protection against any serious accident is too trifling to be considered, whilst, with the cranks as close together as possible, the cylinders are completely protected.

"We offer these remarks as our views merely, and with all due deference to the superior skill of Messrs. Baldwin and Rogers. Mr. Rogers, in common with all other experienced machinists with whom we have conversed, is decidedly opposed to any increase of width of track beyond 5 feet, with the present weight of engine.

"As regards the power of the engines, they are able to slip the wheels when the rails are in the best state; this they do in common with all good American or English engines, consequently any accounts of extraordinary performance would be worse than superfluous, when we know that they will do all that any other engine whatever, with the same weight on the driving-wheels, possibly can do.

"As a last remark, we would observe that there is more finish on the engines of Messrs. Rogers, Ketchum & Grosvenor than we are in the habit of seeing; some parts usually painted black being highly polished. On the whole we consider their new establishment eminently calculated to add to the reputation of American locomotives, as it has for many years largely contributed to the character of American machinery for the manufacture of cotton and other objects."

Soon after he commenced building locomotives, Mr. Rogers became convinced that inside-connected engines, with crank-axles, were inferior in many respects to outside-connected ones, besides being more expensive to build and to keep in repair; he also became satisfied that in the matter of steadiness, the inside-connected had no advantage over the outside-connected engine, and that, with proper counterbalancing, the latter could be run as fast as required without any injurious oscillation; and also, that it required more skill to properly counterbalance inside-connected engines than outside ones. Therefore, he was an earnest advocate of this style of engine, and recommended outside connected-engines as better than inside-connected ones.

Fig. 15 represents the "Stockbridge," built in 1842, with outside cylinders. In this engine the driving-axle was placed in front of the fire-box, and a pair of trailing-wheels behind to carry the overhanging weight. The load on the driving-wheels was, of course, reduced by an amount equal to that carried by the trailing-wheels, so that this type of engine was also deficient in adhesion and power.

The next step which was made was to substitute a pair of driving-wheels for the trailing-wheels, and couple them with the main driving-wheels. This form of engine, shown by Fig. 16, was patented in 1836 by Henry R. Campbell, of Philadelphia, and was adopted by Mr. Rogers in 1844. This plan has since been so generally adopted in this country that it is now known as the "American" type. Fig. 17 represents an engine of this kind built at the Rogers Works in 1844. It had

four coupled driving-wheels and outside cylinders. the eccentrics were on the back axle, the pumps were full stroke, worked from the cross-heads. It had springs over the back axle bearings, and also in the centre of the levers which extended from the driving-axle to the centre of the truck on each side of the engine. The truck was pivoted and turned upon a centre pin fixed to the boiler; the arrangement did not give satisfaction, and was altered after a short trial. This engine was remarkable from the fact that it is the first example of the use of an equalizing-beam between the driving-wheels and truck.

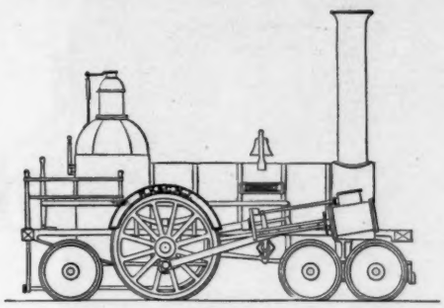


Fig. 15.

The engine shown by Fig. 18 was built in 1845, and had equalizing-levers between the driving-wheel springs; the truck had side bearings and springs over the sides of truck; the pumps had short stroke and were worked from the cross-head, as shown.

Fig. 19 shows an engine built in 1846 with the driving-wheels spread well apart. It had V hooks and independent cut-off on the back of the main valves; this was a favorite kind of engine for many years.

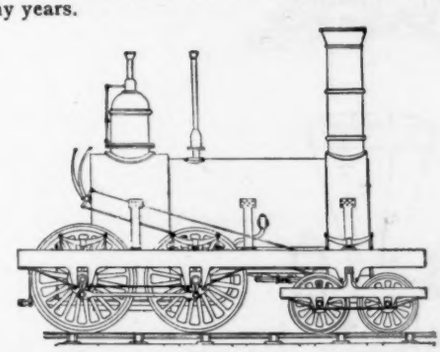


Fig. 16.

In 1848, Mr. Rogers was requested to furnish some engines with six-coupled wheels for the Savanilla Railroad in Cuba. He then designed and built the first ten-wheeled engines ever made at the Rogers Works. There is no drawing of these engines extant. They had, however, outside cylinders 15½ inches diameter by 20 inches stroke. The ten-wheeled engines which had been built previous to this time had inside cylinders and crank axles. The connecting rods of the engines for the Savanilla Railroad were made to take hold of the outside jour-

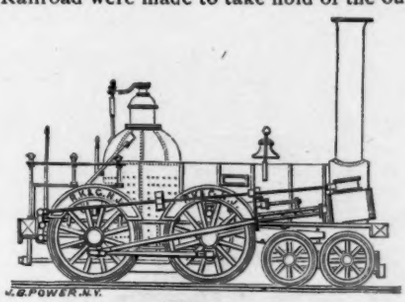


Fig. 17.

nal of the main crank-pin, which at that time was a new departure.

Fig. 20 represents a plan of ten-wheeled engine, with half-crank keyed on the driving-wheel, same as Baldwin's plan. This pattern of engine was built in 1848 after those for the Savanilla Railroad. The engine had outside bearings and equalizing-levers between the springs; it also had cranks on the axles outside the frames to which the coupling-rods were attached. A number of engines on this plan, with cylinders 17 × 22, were built for the New York & Erie Railroad. They all had independent cut-off valves.

Fig. 21 represents an inside-cylinder engine with full crank; the steam-chests were inclined sidewise, so that the valves could be readily got at. This was one of the improvements introduced by Thomas Rogers. The engine had V hooks and independent cut-off valves, and was built for the Paterson & Hudson River Railroad.

On the style of engine shown by Fig. 22, the shifting-link motion was introduced. Thomas Rogers was one of its earliest advocates, and did more toward its successful introduction on American locomotives than any other person. He was not only an early, but an earnest advocate of it, at a time when it was condemned by some of the most prominent en-

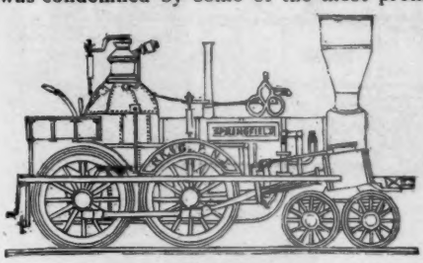


Fig. 18.

gineers in the country. Time has amply proved all that he claimed for it, which was, that it is the most simple and efficient form of valve-gear that has ever been devised.

Fig. 23 represents a style of passenger engine which was first built in 1852. It had 15 × 22 inch cylinders, driving-wheels 5 feet in diameter. It had what may be called supplementary outside frames, which carried the running-board, cab, etc. It had shifting links, hung from below, and the truck axles had both inside and outside bearings. The form of engine repre-

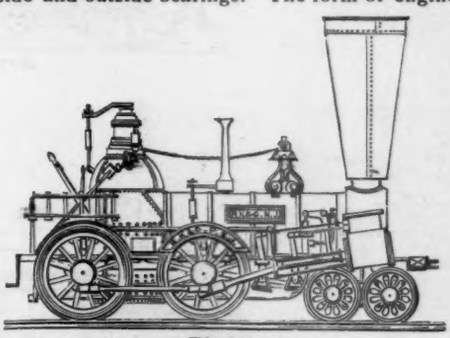


Fig. 19.

sented by Fig. 24 was first built in 1853, and was for a long time very popular. The cylinders were 16 × 22 inches and the driving-wheels 5 feet diameter, although the size of the latter was varied somewhat in different engines.

On the death of Mr. Thomas Rogers, which occurred in 1856, the business theretofore conducted by Rogers, Ketchum & Grosvenor was reörganized under a charter, with the title of The Rogers Locomotive & Machine Works, and Mr. William S. Hudson was then appointed superintendent. He

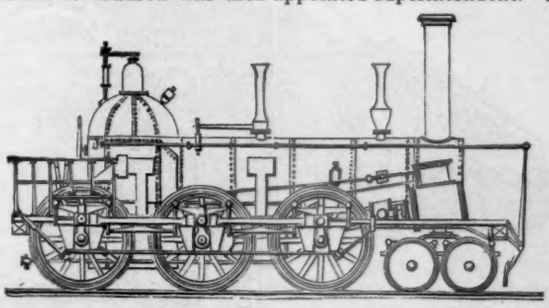


Fig. 20.

was a prolific inventor and an excellent mechanic, and introduced many improvements in locomotive construction, which will be described further on.

The first "Mogul" engine, Fig. 26, built at the Rogers Works, was completed in 1863. This plan of locomotive was made possible by the invention of the Bissell truck and the addition of the swing links to it by A. F. Smith, both of which will be described in another chapter. With a single axle-truck in front of the cylinder, the front driving-wheels can be placed

farther forward than they can be on a ten-wheeled engine with a four-wheeled truck, one axle of which is in front, and another behind the cylinders. Consequently "Mogul" engines have a larger proportion of their weight on the driving-wheels than ten-wheeled engines have, and this has brought the "Moguls" in favor for freight service.

The demand for more powerful locomotives naturally suggested coupling four pairs of wheels, and led to the "consolidation" type, which has eight driving-wheels coupled, and a pony truck in front of the cylinders. In 1880, the first "consolidation" engine built at the Rogers Works was completed.

The types of engines which have been described, are the principal ones which have been evolved in this country for ordinary freight and passenger service. Besides these there has been a demand for locomotives for special service, such as switching, urban and suburban traffic, and for narrowness of which made it essential to design special methods of construction.

The most common plan used for switching-engines is that which has four-coupled wheels, both axles being placed between the furnace and smoke-box. Separate tenders are furnished with locomotives of this kind, or the tanks may be placed on top of the boilers.

When more powerful engines are required, six-coupled wheels are used with the axles, all between the furnace and smoke-box. Some six-coupled engines have been built with an axle behind the fire-box, but with this arrangement the overhanging weight of cylinder, smoke-box, etc., brings an

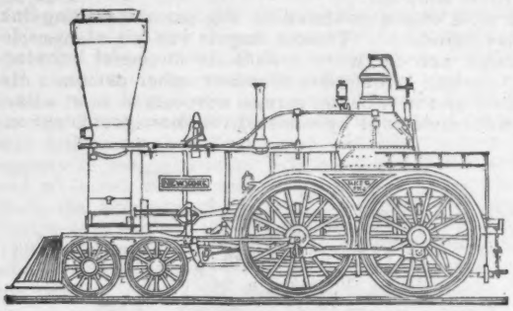
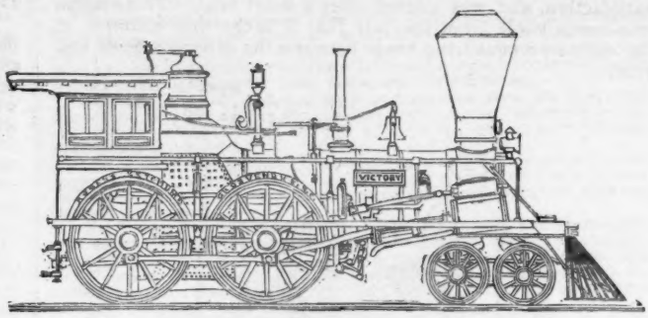


Fig. 21.

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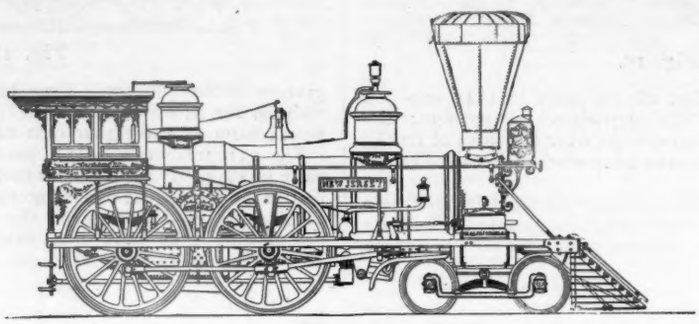

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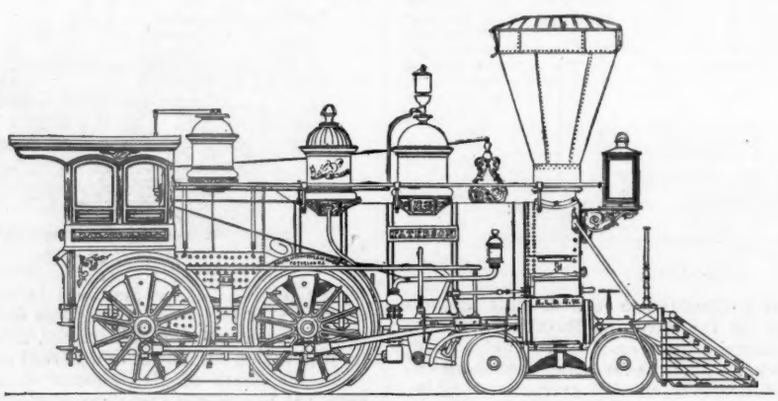

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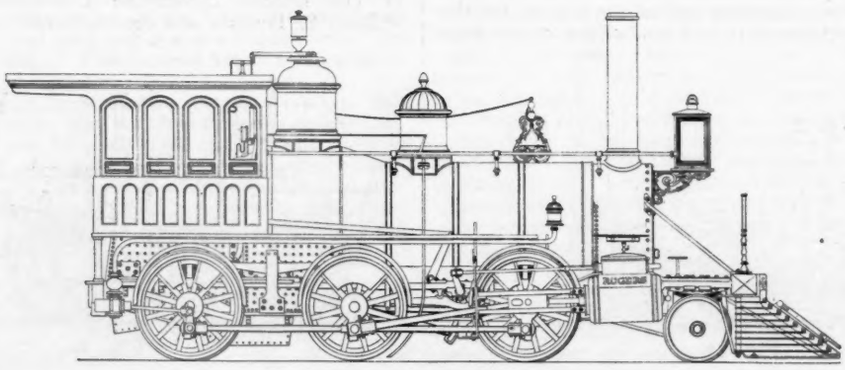

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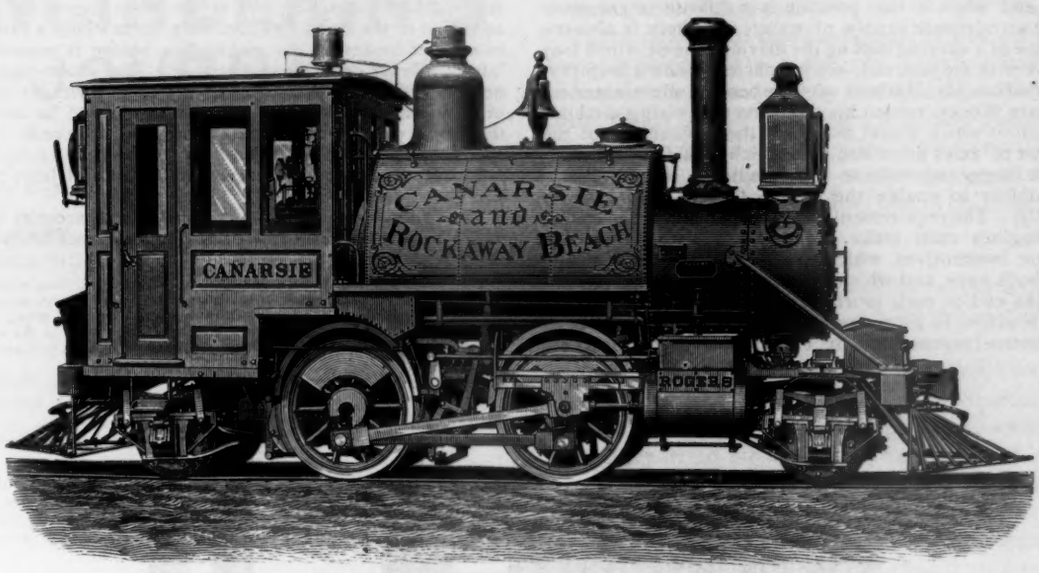


Plate I.

HUDSON'S EIGHT-WHEELED DOUDLE-END LOCOMOTIVE.

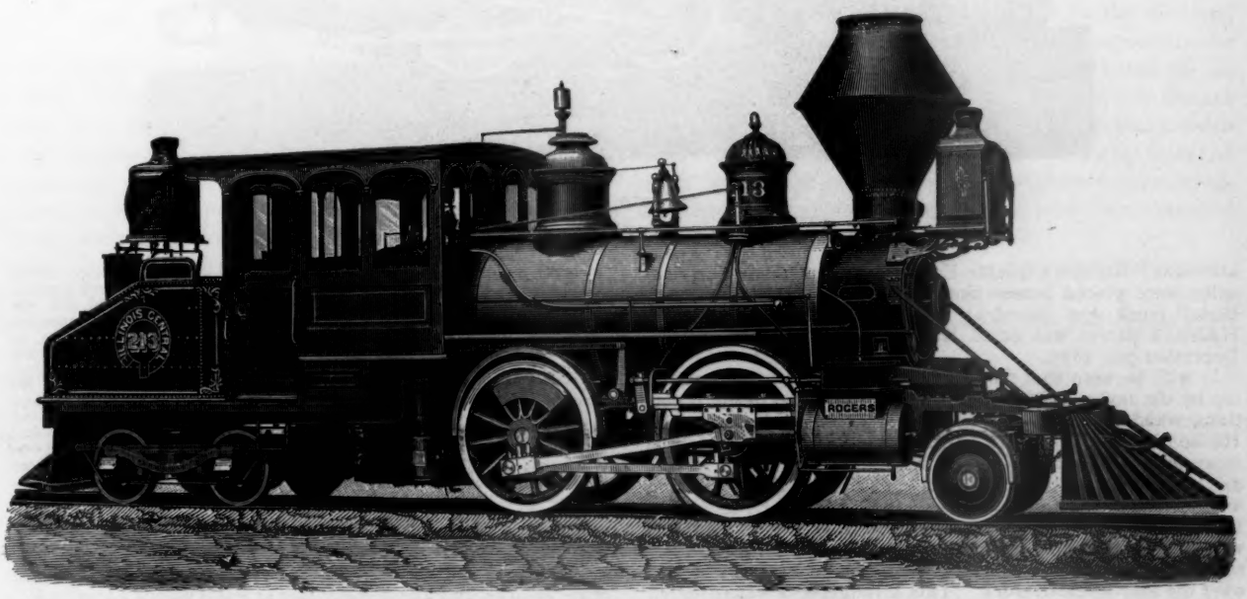


Plate II.

HUDSON'S TEN-WHEELED DOUBLE-END LOCOMOTIVE.

undue amount of weight on the front pair of wheels.

The advantage of locating the driving-axles between the furnace and smoke-box is, that the overhanging weight of the furnace behind balances that of the cylinders, smoke-box, etc., in front, and in this way the driving-wheels carry the whole weight of the engine, and it is equally distributed upon them. Placing the water-tank on top of the boiler is inconvenient and unsightly, and when in that position it is difficult to get room enough for an adequate supply of water, and there is also the disadvantage of a varying load on the driving-wheels, which may be excessive with the tank full, and insufficient when it is empty. For these reasons Mr. Hudson, after he became superintendent of the Rogers Works, turned his attention to devising methods of construction which would retain all the advantages of the arrangement of axles described, but which would at the same time give a longer wheel-base for steadiness, but with sufficient flexibility to enable the engine to run around sharp curves easily. The requirements of suburban and other traffic, in which engines must make short runs, had also created a demand for locomotives which could be conveniently and safely run both ways, and which would not require to be turned around at the end of each journey. Having these objects in view, Mr. Hudson, in 1867, designed and patented the plan of tank locomotive represented by Plate I, which soon became known as "Hudson's Double-Ender." In this, the two driving-axles were placed beteen the furnace and smoke-box, and a Bissell truck was placed at each end of the engine. Mr. Hudson's patent was dated May 7th, 1867, and was reissued December 7th, 1875.

It will be seen that the water-tank of these engines was on top of the boiler. This arrangement was open to the objections which have been pointed out. To overcome these Mr. Hudson, in 1872, designed and patented the plan of engine represented by Plate II. In this the arrangement of the driving-axles and the front truck, excepting the equalizing arrangements, are the same as in the "Double-Ender" plan, but instead of a two-wheeled Bissell truck behind, a four-wheeled swing-motion truck was substituted, and the water-tank instead of being placed on top of the boilers, was placed over the four-wheeled truck. This arrangement was patented July 16th, 1872.

In 1866, Mr. M. N. Forney patented the plan embodied in the engine shown in Plate III. A number of engines of that kind have been built at the Rogers Locomotive Works for various roads. Whether a leading truck is essential for engines of this class has been a subject of a good deal of controversy among railroad engineers. To reconcile the views of the various parties to this dispute; the Rogers Works build locomotives either with or without the leading truck, as required, leaving to the purchaser and user the task of determining whether a leading truck is useful or not.

In 1872, Mr. Hudson took out seven patents for different plans of tank engines with trucks at each end. In all of them his system of equalizing levers between the trucks and driving-wheel springs, which is described in another chapter, was used, and his patents were chiefly for various applications of that system.

He also patented, in 1873, a plan for a compound locomotive. This had two outside cylinders in the usual position, the one being of larger diameter than the other. It was intended that, ordinarily, live steam from the boiler should be admitted to the small cylinder only, from which it exhausted into a super-heater in the smoke-box before it passed into the large cylinder on the opposite side. The steam-pipe was connected with the steam-chest of the large cylinder by another pipe of smaller diameter. Live steam could be admitted by the small pipe to the large cylinder, if required. This plan was never put into practice.

Mr. Hudson's death occurred on the 20th of July, 1881. He was then 72 years old.

The following extracts are taken from an account of his life, which appeared in the *Railroad Gazette* immediately after his death.

"He was born near the town of Derby, England, in 1809, and at an early age began to learn the trade of an engineer and machinist, serving part of his apprenticeship under George Stephenson. In 1833, when 24 years of age, he came to this country, and for a time found work in the engine room and machine shops attached to the Auburn State Prison in New York. He soon left that place, however, and engaged as a locomotive runner on the old Rochester & Auburn Railroad, now a portion of the New York Central. Subsequently he ran an engine on the Attica & Buffalo Railroad, and was made master mechanic of the road, which he left in 1852 to become superintendent of the locomotive works of Rogers, Ketchum & Grosvenor, at Paterson, N. J. In 1856, these works were incorporated as the Rogers Locomotive and Machine Works, and Mr. Hudson was made mechanical engineer and superintendent, a position which he held until his death. He succeeded Mr. Thomas Rogers, who was the founder of these works, and who probably did more than any other man to develop the design and improve the construction of the American locomotive as it is to-day. But Mr. Hudson took up the work where Mr. Rogers left it, and during the 30 years that Mr. Hudson occupied the position of head of the mechanical department of this establishment, he made many improvements in the locomotives built there, chiefly of a kind which are the result of simplifying details, adopting better methods of putting work together, and making the engines more substantial and more serviceable. He studied, as probably no other locomotive builder did, the performance of the engines he built. He was constantly looking out for their weak points, and it was said by the present head of the establishment, that Mr. Hudson was always more concerned about building a good engine than he was in making a good profit."

(*To be continued.*)

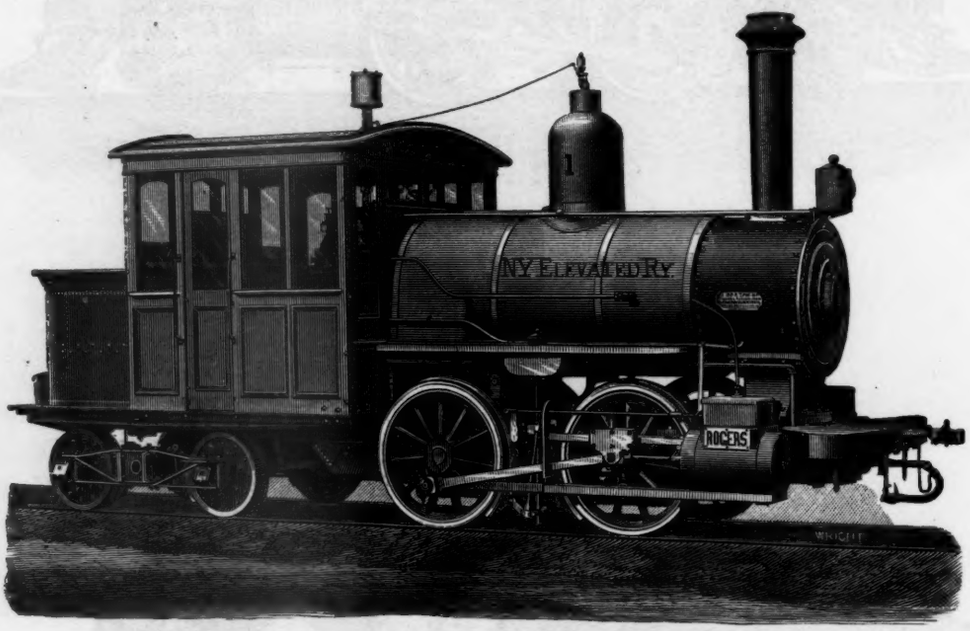


**Plate III.**

FORNEY LOCOMOTIVE.

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**Mr. Stevenson Towle** has been appointed as an expert to examine and report on the system of sewerage now in use in Central Park, New York.

**Mr. Virgil H. Bogue**, lately with the Nothern Pacific, has been made chief engineer of the Union Pacific Railway, succeeding Mr. Blickensderfer, who has been chief engineer since 1879. The change was made with the sole view of increasing the engineering staff, Mr. Blickensderfer still ermaining with the company as consulting engineer.